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LABOUR QUESTIONS IN ENGLAND AND AMERICA.

By Charles Buxton Going.

LESS than three years ago, Mr. J. Stephen Jeans concluded an article* in these pages with the following paragraph—remarkable, as current events have proved, for its prophetic quality:

"The most important and pressing problem presented for solution, so far as the United States are concerned, is whether the British situation or the American situation in relation to trade unionism is to be the industrial situation of the future. Neither country can stand still in view of the changing conditions presented by the great social upheaval that is going on all around. Labour is unquestionably more highly organised in Great Britain than in any other country. Is this not the inevitable result of Great Britain's priority of place as a manufacturing country? And, if it is due to that factor, is it not probable that in newer countries labour will acquire the same power and use it as remorselessly as it is now being used in leading British industries? If so, is it not probable that we are approaching a period when the troubles that have been faced and fought in Britain will engross the thoughts and efforts of American manufacturers? In other words, is the struggle between capital and labour being fought out in Britain once for all, or will it have to be gone over again, *mutatis mutandis*, in other industrial countries? Is the present British attitude of capital and labour the last word in this controversy, or may we look in the near future for conditions more nearly assimilated to those that prevail in the United States?"

Events follow fast in modern industrial life. The great British labour struggle, in the midst of which Mr. Jeans was writing, was ended

* Lessons of the Great Engineering Strike in England. J. Stephen Jeans. The Engineering Magazine, Sept., 1897.

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about five months later by a treaty under which England's mechanical trades have enjoyed a prosperity beyond all precedent, and under which also the relations of employer and employee are maintained with a smoothness, a freedom from break, or even severe strain, and a confidence of stability above anything heretofore known. Two years more and the field of battle, or of threat of battle, is shifted to the United States. It seems doubtful now if the issue will really be joined at this time. Both sides seem willing to temporise—the men, perhaps, because not sure enough of their position—the manufacturers, because they believe that a better time can be found for making a final stand. But at some time and in some way the case must be tried on its merits before the court of public opinion, decided by the inevitable rulings of industrial laws, or "settled out of court" by the now contending parties through the exercise of sober reason, in the light of the clear facts and changeless logic of industrial evolution. And as evolution becomes apparent by reading back in the life history of a type, or by studying the successive stages of progress in kindred forms, the recent history of English labour conditions is of the highest interest at present. For the American manufacturer, it points surely to the way in which affairs in his own country are tending; to the British engineer employer, it indicates the future of one of Britain's greatest competitors and stimulators in engineering work.

There is a curious likeness between the seeming and the real issues in the two countries. In each, the demand which the men put most conspicuously forward—the one of which press and public have heard most—is that for reduction of the length of the working day. This portion of the demand of the English trade unions is thus summarised by Mr. Jeans in the article already referred to:

"The workmen, in making the present demand, claim that a reduction in the hours of labour is required, in order to give the workmen more time for study and recreation; that the proposed system would enable the workman to start work in the morning with his breakfast, and consequently in a fitter condition for actual labour; and that the effect of reducing the hours would be to provide more employment, and consequently to reduce the number of artisans out of work. Another claim has been made, strangely inconsistent with the one last-named—namely, that under the improved social conditions assumed, the average workman can do as much work in eight hours as in nine.

"On the other hand, the employers refuse to admit that the claims of the workmen are reasonable, or their reasoning accurate. They argue that the reduction in the hours of labour would mean an increase

of 5 to 10 per cent. in the cost of production, which would be disastrous in face of the severe foreign competition now prevailing; that already they have the utmost difficulty in securing orders against continental countries and the United States; that, as all machinery in well-regulated shops is already worked to its utmost capacity, it would be impossible to make up for lost time; that, apart from this controlling aspect of machinery, their experience of the nine-hour-day change did not show that workmen were ready or competent, as a general thing, to do as much work in a shorter period as in a longer period; that establishment charges could not be reduced in proportion to the reduction in hours; that the change would increase, *pro rata*, the maintenance of machinery; and that, if the eight-hour day is to be adopted, it should be accompanied either by a reduced rate of wages, *or by the removal of the restrictions at present imposed by the workmen's unions, in reference to piece-work, apprentices, over-time, the working of machine-tools, and other matters.*"

The concluding words are italicised in quotation, because in them lies the suggestion of the real issue which was at stake in the English, and now is in the American, labour situation. If the reduction of the hours of labour had indeed been the sole question, it is doubtful if the employers would have made any very uncompromising stand, or would have received any very strong support from public opinion had they done so. It is, indeed, noteworthy and confirmatory of the position assumed above—that England is a prototype of the United States in the evolution of labour conditions—to observe that as long ago as 1870 there was adopted, in British mechanical works, the nine-hour day for which American machinists are now agitating.

There are, of course, many things to be most carefully considered and adjusted before any such change can go into effect. Unfilled contracts, or established prices for product, are the most obvious; the longer hours of idleness for expensive plant can by no means be ignored. But with proper compensation in the *manner* of working, there is little question that the *hours* of working might be materially reduced without loss of wage earnings to the workman nor increase of cost of product to the employer. Actual practice under the piece-work system has proved this too often and too definitely to leave much room for argument on the other side. In fact, the theorem that a man's labour-production is directly proportional to his hours of working, is almost as fallacious as the trade-union proposition that the amount of wage-winning work in the world is a definite quantity, and will be exhausted sooner by more diligent working.

The practice of many allied industries and the expressed opinion of not a few shop managers in the United States is in support of the nine-hour day. As one widely known American manufacturer said to me very recently, "the reduction from ten hours to nine seems to me as logical a step to-day as the reduction from twelve hours to ten was some time ago. I may be wrong—the time may not yet be ripe—but I think it is. I think before long we shall all admit that nine hours in the machine shop is a day's work." The movement, in all lines of industry, is toward larger output with less manual labour—more work from the tool, and less from the man. If the "machinery in well-regulated shops is already worked to its utmost capacity," the time has arrived for putting in more, or more efficient, machinery; but that it was *not* so worked in engineering workshops in England in 1897 is clearly indicated by the reference to the "restrictions * * imposed by workmen's unions in reference to piece work, apprentices, overtime, the working of machine tools, and other matters."

Herein lay the really important part of the matter. The demand for the eight-hour day in England, and less openly, perhaps, the strike for the nine-hour day in the United States, but served as a cloak for the actual body of the contention. The real substance of the issue, which united the employers of England—as it is certain to unite the employers of America—into a firmly-knit and finally-determined resistance, was the men's insistence upon the manufacturers' adoption of trade-union regulations in the operation of their works. However it was phrased, it meant in either case the delivery of the employers' business into the control of the men. To quote Mr. Jeans again:

"The present strike, however, is not merely a function of the demand for an eight-hour day. In a larger and wider sense, it is a practical protest of capital against the repeated and persistent attempts of the workmen to control the business of their employers. * * *

"One of these is the limitation of the number of apprentices. Another is the limitation in the number of machines which a workman can attend to—the union forbidding a man to work more than one machine, and in many cases more than one tool on each machine; while frequent attempts have been made to fix a minimum rate of wages.

"In American practice, as I am informed, there are no such restrictions on piece-work as in England, but each workman, acting on his own initiative, as a rule, makes his own individual arrangements."

The lapse of two years' time has brought about startling changes on both sides of the Atlantic—none more amazing, perhaps, than the American workman's willful abandonment of what Mr. Jeans called

the "freer ideas and habits," which formerly were his, for the "demerits and disadvantages of the British system." It is but a short time since Mr. Hiram S. Maxim said:* "I do not believe that 1 per cent. of the highly skilled mechanics of the great workshops of New England belong to any sort of trade union. Trade unionism, if it exists at all, is confined to the unskilled labourers." And now the United States is menaced with a strike of the machinists, national in its extent and paralysing in its completeness. The whole country is to be "tied up," if necessary, to enforce the demand for—not merely the nine-hour day; that is a stalking horse—the "recognition" of the union by the employment of none but union men "in good standing"—that is, those who work under the union regulations in all things, including limitation of the number of apprentices; prohibition of piece work; refusal to run more than one machine, to work with non-union men, or to give any instruction to a handy man; dictation of minimum wages, and even limitation of product or of speed of working.

Those who read Mr. Norris' recent papers† will have gained some idea of the extent to which union domination has extended in the mechanical industries of the United States. There is no phase of the tyranny, of the stolid opposition to progress, of the blind adherence to false socialistic philosophy, of the cherishing of the "lump of labour" and other economic fallacies, of the determination to rule or ruin characterising British trade unionism, which does not appear in full vigour in the efforts and aims of the present labour unions of the United States.

The astounding and deplorable thing is that this line should be taken in the face of the certainty that the freedom and good sense formerly characteristic of the American working man have been the chief factors in bringing prosperity to him and to his country. He has been the most highly paid workman in the world because he was the most productive. And because their workmen were the most productive, the United States have won their way into the world's markets for machinery and machine tools. They have won it against competitors whose start was enormous, whose lead seemed to be too great ever to be closed up, but whose burden of conservatism and hobbles of labour restrictions held them back until the younger rival, late in the start but free and untrammeled in movement, had breasted and seemed ready to pass them. And now the chain and drag of trade-union making, which Britain has partially freed herself from after bitter and costly

* National Differences in Labour-Handling Methods. H. S. Maxim. The Engineering Magazine, Dec., 1897.
† Actual Experience with the Premium Plan. H. M. Norris. The Engineering Magazine, Jan., Feb., 1900.

effort, the machinists of the United States are preparing to put on! Mr. Slater Lewis, elsewhere in this issue,* clearly indicates the satisfaction with which the competing trades of other countries would regard such a movement.

There would be certain and permanent loss to the United States from an extended strike, even though the men—to their own enduring advantage—were to lose every point for which they seem disposed to contend. Beyond the immediate loss of wages to the men and of profitable orders to the employers, a certain, and perhaps considerable, amount of business would go elsewhere never to return. Trade, forced into new channels, is often loath to return to the old ones. America was a permanent gainer by the long protracted British engineering strike. She would be a permanent loser by similar troubles at home. Germany, as a competitor, is keener and more strenuous even than she was two years ago. England, awakened in every part, has been undergoing a reorganisation approaching almost to an industrial revolution. Expansion in the machinery trades, which was won with comparative ease by the United States when the conditions were peculiarly favorable to them, would be hard to hold when the conditions were adverse—harder still, if once it slipped away, to regain from competitors who now blend the best America's mechanical skill has devised with a commercial system she can as yet but faintly parallel.

But would a general strike of the machinists in the United States, forced along lines laid down in Chicago, end in victory for the men? Once more we may turn to England's great engineering strike for a forecast. The curves have been so far alike that we may be sure they have the same elements, and the path of the disturbance in the United States may be plotted by its forerunner in Great Britain. In February, 1898—nearly ten months after the opening skirmish—work was resumed in the engineering establishments of Great Britain under a general agreement between the Employers' Federation of Engineering Associations and the Amalgamated Society of Engineers—an agreement which can fitly be described as an utter rout of the men from every stand they had attempted to make. How complete was the emancipation of British industry from union tyranny, under this agreement, a few quotations will indicate.

"Every workman shall be free to belong to a trade union or not, as he may think fit.

"Every employer shall be free to employ any man, whether or not he belong to a trade union.

* Works Management for Maximum Production. J. Slater Lewis. Page 213.

"Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the unions or any other body of workmen in their collective capacity arranging amongst themselves rates of wages at which they will accept work, but while admitting this position they decline to enforce a rule of any society, or an agreement between any society and its members.

"Employers are responsible for the work turned out by their machine-tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine-tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen.

"The right to work piece-work at present exercised by many of the Federated Employers shall be extended to all members of the Federation and to all their union workmen."

This was the outcome in a contest precipitated by a labour organisation immensely stronger, absolutely and relatively, than any in the United States, supported by a "war-chest" far richer than anything at the command of the International Association of Machinists. It was the outcome in a country where trade-union domination had, by long ineffectively-opposed exercise, attained a strength vastly greater and more pervasive than is the case in America.

Of course, against this in the final struggle was arrayed a federated strength of engineering employers correspondingly great; but this union of employers was forced by the conditions to be met, and the lesson has not been lost upon the American manufacturing world. The manufacturers won, however, not because they were strong but because they were right—because they were moving with, instead of vainly trying to oppose, the tremendous flow of industrial evolution. Might and strife were needed to enforce the laws of progress, as military and police forces are needed to enforce the laws of civilisation; but the one, like the other, was not a creator of principles but merely an agent for carrying them out.

The whole story is another chapter in the history of the futile, because mistaken and misdirected, struggle against the introduction of the machine to emancipate the labourer. The first outcry was against the use of machinery at all; now it is against its employment to its fullest possibilities. The old fallacy, that the superseded workman must starve, is given a new dress and put to a slightly altered task, as futile

as the first has been shown to be by the clear light of events. Machinery, in replacing hand work, has not only increased creature comforts and raised the general standard of living to a level undreamed of in advance, but in addition has widened the field for labour to an even greater degree, furnishing profitable work for hundreds where one could find employment before, and bringing up with it to a corresponding plane the functions and the intelligence of the worker. Sooner or later, it must become apparent to all that the use of machinery to its utmost capacity is only a second step in the same movement, destined to be equally beneficent in its results. And in this phase of the evolution the machine shop is the principal field, and the machine tool the chief embodied exponent.

Groundless fears are entertained, by many, of the effect upon the operative of specialisation and the introduction of automatic machinery. It can have but one result: the raising of the former partly-skilled attendant to the grade of a far more highly-skilled tool-maker and designer; the creation, from "common labour," of a new order of skilled tool-operatives; and the opening to both of wider possibilities for mental freedom and growth and the cultivation of the broader interests of humanity.

Perhaps the greatest and most lastingly useful lesson of the British engineering strike is the value of federation, when wisely directed and righteous in purpose. Trade unionism served good and much needed ends in opposing abuses of the employers' power. It has many excellent purposes still to be carried out. But in its unwisdom, it has undertaken measures in which it can be checked and corrected only by such an association of employers as shall not only be just and beneficent in its aims, but strong enough to make them effective.

Such an organisation, it seems to be conceded, has been inaugurated in Great Britain. Of the needs and opportunities for the institution of its counterpart in the United States Mr. Hoyt, one of the ablest exponents of the movement, writes in the following article. Should the strike of the International Association of Machinists not spread to the threatened proportions, it will afford only a happier opportunity for developing, steadily but dispassionately, the growth of a manufacturers' federation which will go a long way toward making a future "labour war" impossible—because it will reveal itself as the truest friend and most helpful aid to men, as well as to employers.

MANUFACTURERS' ASSOCIATIONS, LABOR ORGANIZATIONS, AND ARBITRATION.

By H. W. Hoyt.

IN an address before an association of manufacturers recently, a practical economist, who is himself an extensive manufacturer, made the following significant statement when speaking of the beneficent results flowing from the national arbitration of labor disputes in his line of business:

"The result of all this is that we have had absolute peace in our business. In the management of our business during these thirteen years I do not think we have ever given a single day to the consideration of labor questions, and never have been compelled to publish on our letter-head that 'All agreements are subject to strikes and other occurrences beyond our control.'"

So happy a condition of one very large manufacturing industry is chiefly the result of intelligent co-operation among manufacturers whose plants are widely scattered over the United States and whose employees are to a large extent members of an aggressive union. In this instance the union was a fixed fact long years before the manufacturers had considered the utility of co-operation. The relation of employer and employee had become so strained in that trade that financial ruin was imminent. Strikes, often of great violence, were occurring several times annually. Conditions became unbearable, as well to the employee who was a continual loser by his acts of depredation as to the employer who was steadily drifting on the rocks.

In desperation, seeing the inevitable failure of separate endeavor and isolation, a few manufacturers met and laid the foundation of an organization that has now the pleasure and profit of reflecting upon the peaceful and prosperous picture faithfully portrayed by its most distinguished member in the words above quoted. The significant feature of this particular case is the fact that the employee is as well satisfied as the employer.

It is of particular interest to compare Mr. Hoyt's convincing and practical argument for federation of employers in the United States, with Mr. Slater Lewis' clear summary of the benefits already secured by such an association in Great Britain. Mr. Lewis' article will be found on page 211 of this issue. THE ENGINEERING MAGAZINE is fortunate in bringing together two so able advocates in a cause of great current interest.—THE EDITORS

Self interest is the powerful incentive that is first invoked to urge manufacturers into alliances for mutual protection. If this, however, were the only reason for co-operation, it is doubtful whether the far-seeing economist would approve of such an organization. If the National Founders' Association, one of the most powerful of manufacturing organizations, were simply a fighting machine with its guns trained on labor unions, its claims of usefulness would be challenged by every right-thinking man. If the same association were a trade trust whose object was to purchase the services of its employees at the greatest possible bargain, and in turn to dispose of its product at prices induced by some controvention of the natural laws of trade, it would be open to the strongest censure.

Without desiring to direct attention to any particular association, but with the sole object of presenting a type of the greatest interest, it is pertinent in this connection to give the following extract from the constitution of the National Founders' Association:

ARTICLE II.

SECTION I. The objects of this Association are: First, the adoption of a uniform basis for just and equitable dealings between the members and their employees, whereby the interests of both will be properly protected; second, the investigation and adjustment by the proper officers of the Association, of any question arising between members and their employees.

It will probably be conceded that this "object" is pacificatory —in fact, that it exhales the very spirit of peace and good will.

The organization founded upon this basis is intensely practical. During the past year its good offices have been invoked scores of times to relieve strained conditions, and success has been achieved in nearly every instance. Not only has it been able, through the co-operation of its employees, to prevent strikes and lock-outs, but the association has entered the field of arbitration upon a plane seldom attained by anyone except theorists. It has not only shown wisdom in dealing with the concrete relations of employer and employee, but has begun with great zeal to investigate some of the fundamental questions of social economics in their bearing upon the always complicated relations of employer and employee. In the consideration of these subjects and their practical application, the manufacturers have invited and secured the hearty co-operation of one of the most

powerful trade unions now to be found among American organized labor.

The association of manufacturers cited has at least two prototypes whose constitutions are practically identical. Broad as these constitutions are, the actual work of these associations is still broader. They have discovered common ground upon which the employer and employee may safely meet. They have eliminated, to a large degree, the common distrust and the consequent violent contentions. Partial failures to avert industrial wars have been so rare as to invite the hope of ultimate complete success

If it is possible for one branch of industry to achieve emancipation from the exhausting industrial wars, the irresistible inference is that it is equally possible for all trades to do likewise. Many other conclusions are obvious, one of which is that it is a solemn duty laid upon the employers of labor jointly to promote, by organized effort, the mutual loyalty and prosperity of employer and employee. From their vantage ground, the employers should make the first advances. With honest endeavor and with clean hands they should take up the economic questions and invite co-operation from both organized and unorganized labor. They should not allow themselves to become cynical when forced to join issue with the worst phases of unionism. Let them first examine their own position and see if it is founded on justice. Satisfied upon this point, let them bring the whole influence of their financial strength against the encroachments of a tyranny that, however it may oppress capital, is infinitely more blasting in its effects upon labor. Labor organizations have a mission that is justified in every rational mind; but in unwise hands the power of labor organizations often becomes a grievous menace. The members of labor unions sometimes find that they have placed shackles upon their own wrists that they are powerless to cast off. Against such slavery —against the proposition that honest men and good mechanics may be arbitrarily deprived of their rights and driven into helpless poverty—it is the duty of the manufacturers to stand like a stone wall. It is equally their duty to inculcate within their own ranks a spirit of equity that will lead to absolute justice in their relations with their employees.

In reviewing the work of a manufacturers' convention recently held, an impartial critic said:

"Evidently a deep sense of the great responsibility resting

upon their shoulders was felt by the employers present in that assemblage, many of whom exercise authority in that capacity over hundreds of men. It was, therefore, with no light or trifling manner that they decided questions of policy or principles which were brought before them for determination. Without losing sight of the fact that they might at any time be forced to take stern measures to preserve their own rights and perhaps their own business existence, they showed that they were animated by higher motives than the endeavor to get the largest possible profit from the employment of other men. If all defensive organizations can be established and conducted upon the same high plane, the irrepressible conflict between capital and labor will be shorn of much of its unpleasantness.

To reduce the friction which has seemed hitherto unavoidable between the manager's office and the workshop, is a consummation most devoutly to be wished. To eliminate the local business agent and his petty tyranny, and to substitute national agreements between the chief executive officers of employers' and labor organizations, is an enlightened step. It is a movement promising the greatest possible good to both parties. From the broader view of a national standpoint, the perspective is very different from that appearing to the vision limited to the office or shop. Both sides look out on a wider horizon and get a clearer perception of principles. Removed from the local environment men's ideas clear up and trivial contentions are forgotten. The new conditions beget a kindlier feeling and a mutual forbearance.

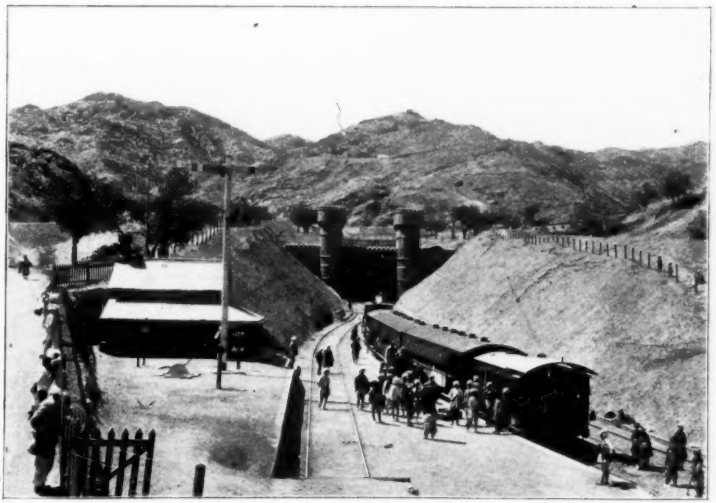
Nor is this all. The manufacturers' associations have been singularly educative. They have certainly broadened the members' views and made them more tolerant of one another. Without in any degree cultivating the slightest tendency toward trusts, as the term is commonly and correctly understood, these associations have led to serious inquiries into shop practices and to the almost total extinction of every undesirable condition. They have, in a large degree, brought about a uniformity of action along well considered lines and elevated the tone of the whole industry.

The labor unions have shown manufacturers the necessity of combining for protection, and some, at least, of the manufacturers associations have shown the way to peace, without employing drastic measures and without dishonor to either side.

RAILWAY OPPORTUNITIES IN THE ORIENT.

By Wm. Barclay Parsons.

THE future of railway development in China and the promise it may hold for engineering interests in Europe and America may, perhaps, best be studied by considering what China's neighbors have done. On one side we have India and on the other Japan. While the Hindoos and Japanese are races different from each other and from the Chinese, the differences are not so great as to destroy the usefulness of the comparison. They are all Orientals, with many institutions—and even religion in part—in common; their countries have a dense population, while they themselves possess a natural disinclination to change established ways, a strong and almost bigoted desire for hand-labor methods, and a tendency towards a suspicion of foreign ways.

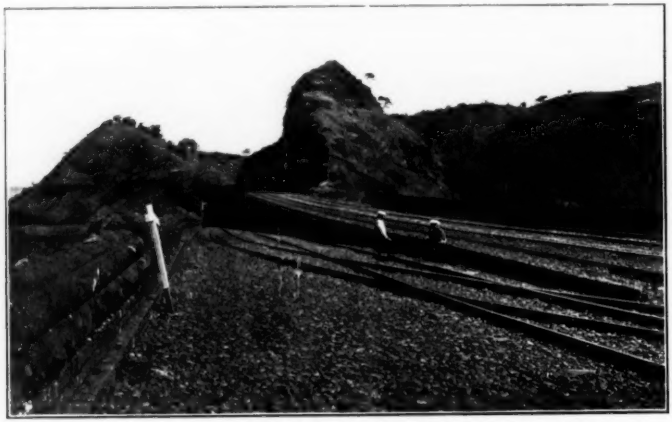


KHOJAK TUNNEL, SIND-PESHIN RAILWAY, INDIA.
Showing station building and passenger train.

The Indian system of railways is of many years' growth, and has now attained a length of 25,000 miles. It may be urged that this gets its strength, and therefore has reached its development, through British, and not native, sources, and consequently is not a fair parallel

for other eastern nations. It is, of course, true that the original incentive and the power of promotion is foreign; but it is equally true that, unless the great mass of people will patronize the newer systems of transportation—no matter how energetically they may be promoted and extolled—they will not pay, and if the first lines do not pay no subsequent ones will be built. The Indian system does pay, in spite of very heavy cost in construction, and pays from the receipts from those classes who usually are not supposed to have the means at hand. The receipts of the whole Indian system amount to $4,000 gold per mile, while the receipts of the "standard-gauge" portion are more than $5,000 per mile, with the chief lines showing results as high as $11,000 gold; and these figures are obtained in a country where the natives are poor as any to be found on the Asiatic continent, and where a heavy mineral traffic, such as that in coal, is not obtainable, as it is in the more favored Oriental countries.

The Japanese railway system, however, is quite free from the objection that may be brought against the Indian railways as standards of comparison, because here we have all Oriental conditions without foreign pressure, except as foreign engineers or others may have been



REVERSING STATION, BHORE GHAT INCLINE, GREAT INDIAN RAILWAY.
Showing substantial construction of road bed.

retained from time to time for advice; and, therefore, in the Japanese system we find an example by which we can judge of the possibilities of development, as to the Oriental's capability not only to adapt himself to new conditions, but to take up the construction and manage-

ment of so essentially an occidental idea as a railway, and of his own initiative to suggest, promote, and carry out new lines.

The case of Japan is peculiar. In 1855, prior to the visit of Commodore Perry, it was a country practically closed to the outside

AN IMPORTANT STATION ON A JAPANESE RAILWAY.

world, and was therefore far behind its neighbor, China, which had been carrying on trade with foreign nations for over three hundred years. In 1870 there was undertaken the construction of a line from Tokyo, the capital, to Yokohama, the chief port, a distance of 18 miles, and this began its operations in 1872. In 1893 the system had grown to 1,871 miles, and at the present time there are in actual operation about 4,000 miles.

These railways are of three kinds: First, the government line, which constitutes the main stem, from Tokyo westerly along the coast through the great centres of trade and population, Yokohama, Kyoto, Asaka and Kobe; secondly, private lines, built with the aid of a government subsidy; thirdly, private lines, without government aid. Of the existing mileage, about 900 miles belong to the government and 3,100 miles to private companies, of which the most important is the Nippon Railway Company, whose lines run east and northeast from

A SMALL JAPANESE RAILWAY STATION.

Tokyo. The early Japanese lines were built by foreign, usually English engineers and operated by foreign managers. But nearly all the foreigners have been replaced by Japanese officials, three only—two in the operating and one in the tariff departments of the government employ—being retained. No new ones are now engaged, the natives having amply demonstrated their ability to do all the work of planning, constructing and operating.

The principal lines are double-tracked. Such single lines as exist are operated according to the English system of the train staff; and as the enginemen are natives, at wages averaging $12 per month, some such mechanical method, instead of the American system of telegraph dispatching, is a necessity. The track is of the American type, with flat-footed rails on wooden crossties and stone ballast. The rolling stock is of the European design, with cross compartments in the passenger cars and freight equipment of the "truck" order. The locomotives, on the other hand, are both European and American. In order to suit the passenger cars the stations have high platforms, and the buildings, though simple in design, are effective and usually

models of neatness. Passengers are not admitted to the platform except with tickets, and are not allowed to cross the tracks except by an overhead bridge. The train schedules are generally generous in regard to frequency of trains, giving speeds of 20 to 30 miles per hour, with trains usually on time.

The results of operation are in every way satisfactory, and are sufficient to dispel completely any fear as to the Oriental failing to appreciate modern conditions when he has become used to them; for it must be kept in mind that it is only within the last few years that Japan has attained commercial prominence, and that it was but a short time since when she occupied a position inferior to other Asiatic peoples. The government lines earn per mile per annum about $8,000 gross, while the private lines, many of which are located in the sparsely settled and mountainous districts, succeed in averaging $3,500; but, owing to the low cost of labor, the ratio of operating expenses is much lower than is found in the United States, ranging from 40 per cent. to 50 per cent., thus giving a higher net return than is usual with equal gross receipts on railways in the United States.

Japan being an island, the railways are subject to junk and steamer competition, and as the Japanese coal mines are located on the sea,

A JAPANESE PASSENGER TRAIN.

such traffic is almost exclusively water-borne. The former condition deprives the railways of through freight, and the latter of coal and similar classes of heavy goods, except to interior points. The anomaly to American eyes in the returns is the fact that passenger receipts exceed those from freight, the ratio of earnings on the government lines being about as three to one, although on the private lines, where the population is much less dense, there is a nearer approach to equality. The same state of affairs is found to exist on the Indian system and on the Imperial Chinese Railway so far as it is built, indicating the existence of similar conditions of life throughout all the East. Contrary, therefore, to the ordinarily accepted belief, the Ori-

JAPANESE FREIGHT STATION AND FREIGHT CAR.

ental is by nature a traveler when he gets the opportunity, and the extent to which he will travel is enormous. On the 660 miles of government lines in Japan, for the year 1898, there were carried no fewer than 28,000,000 passengers, an average per mile of 42,000. The average number of passengers per mile of railway in the United States is about 3,000. Taking a more striking comparison, the whole Japanese system, government and private, in 1898 aggregating 2,468 miles, carried 84,040,963 passengers, while the New York Central, in the same year, with 2,395 miles—or almost exactly the same length—carried 24,074,254 passengers, giving a relative density in favor of the Japan-

ese of more than three to one; and this in spite of the fact that the New York Central had the benefit of including among its passengers all the traffic received from western, New England, and other connecting lines. Even when making a comparison as to passenger mileage, the volume of business is in favor of the Japanese systems as two to one; the passengers carried one mile being in one case 1,438,014,632, and in the other 712,115,222.

Nor are the rates of fare at which this business is done so very low; in fact, some of the charges are so high as to excite the envy of an ordinary American traffic manager. In India there are four classes

FIRST-CLASS CHINESE PASSENGER TRAIN AT A MEAL STATION.

of passenger accommodation, the rates per mile ranging from 0.3 cent to 2.4 cents. In Japan there are three classes, the charges being 0.7 cent for the third class, 1.4 cents for the second, and 2.1 cents for the first; these last rates, adopted one year since, are an increase of one-third over the previous figures, it being found that the natives demanded better facilities and were willing to pay for them. On the Chinese Imperial Railway the rates are 1½ cents for first-class and ¾ cent second-class, at which prices, considering the shortness of the line, an enormous business is done. Although the rates for the lower classes seem low, it is to be remembered that the accom-

modations offered are of the simplest and cheapest character, passengers in China being transported in open gondola cars. The charges for first-class travel in all countries are seen to compare favorably with American charges, again bearing in mind that the heavy, expensively decorated American coach is unknown. But freight rates are proportionately higher, the larger charges being rendered possible by competition with man-carried transportation, in which necessarily the cost is great. In India the freight tariff per ton per mile ranges from 1.6 to 5.5 cents; in Japan on ordinary goods from 1 to 2 cents with

USUAL TYPE OF FREIGHT AND SECOND-CLASS PASSENGER EQUIPMENT, CHINESE RAILWAY.

reductions for large consignments, and in China from 1.2 to 2.25 cents. In 1898 the average charge per ton per mile on the whole Japanese system was 1 cent, as compared with 0.6 cent on the New York Central.

There is one form of railway development which as yet has made but little headway, but which is certain to attain great success, being peculiarly suited to the needs of the Chinese on account of the density of population, and the inherent tendency of the natives to individualize; that is, the electric trolley. The short journey will be the rule, and journeys made at all hours, rather than at fixed intervals, on a regular schedule. The electric tramway has just secured a foothold in Japan, in Siam, and in a few other isolated points; a few years hence will see its general application.

There is one curious feature in connection with Oriental railways,

and that is the diversity of gauges, with the entailed certainty of all the inconveniences, delays, and unnecessary expenses that were experienced in the United States until a uniform gauge was at last adopted. The gauge of the Japanese system is 3 ft. 6 in., which is found to be inconveniently small; but as all the lines are alike, and as no outside connections are possible, it is not likely that any change will be made—at least, not for a long time. On the continent the matter is more complicated, and one that some day will certainly give trouble. The Russian Trans-Siberian Railway, and the Chinese Eastern Railway (which is the extension of the former through Manchuria, still nominally Chinese territory, to Port Arthur and to a connection with the Chinese Imperial Railway), has a gauge of 5 feet, in accordance with Russian standards. The Indian railways, on the other hand, have an assortment of gauges; one of 5 ft. 6 in., miscalled the "standard gauge," is used on the principal lines to the extent of about 14,000 miles. A gauge of 1 metre is in force on over 10,000 miles, while odd gauges of 2 ft. and 2 ft. 6 in. are found on a number of short lines, aggregating, however, nearly 1,000 miles. The Chinese authorities on the Imperial system in the north, and on the Shanghai-Woo-sung line, have adopted the European and American standard of 4 ft. 8½ in.: and as the same dimension is being followed by the Belgians on their Hankow-Peking line, and will be used on the English and American concessions, this will dominate the Empire, and to it in the end the Russian and Indian railways will have to conform.

As a field for the future, of course, China stands pre-eminent on account of its size, its population, and its well-known but undeveloped mineral wealth, offering chances and opportunities that are to be found nowhere else in the Orient. It is easily seen that the Chinaman was once an engineer of no mean ability, and the question now is whether he can become an engineer in the future, especially in transportation methods. Reasoning by analogy is our only means of answering. The Japanese, in his essentials does not differ radically from other Orientals. Starting from a point much inferior in the way of commercial development to the Chinese, he has built up, the greater part by his own individual, unassisted efforts, a railway system that can take rank with the railways of any other country. What he has done other Orientals can do, and will do, especially as the conditions for success on the mainland, with possibilities for through traffic and vast mineral deposits awaiting rail transportation outwards, exceed those of insular Japan. The engineering development of the Far East is bound to be one of the great achievements of the coming century.

THE INCREASING DEMAND FOR LIGHT-DRAUGHT STEAMERS.

By Waldon Fawcett.

PROGRESS in that branch of the ship-building industry which concerns the construction of light-draught steamers has, during the past few years, afforded a record of evolution so rapid as almost to suggest a new era of development. This has been due primarily to a number of contributory influences which have been exerted simultaneously, if not conjunctively, in both hemispheres.

Colonization and exploration have been elementary factors. This is well illustrated by the French, and more particularly the British operations in Africa. The campaign conducted by Lord Kitchener in the Soudan called into requisition light-draft steamers and gunboats as important adjuncts of one of the most admirable transport systems ever devised—not so much because it was of greater magnitude and more systematically conducted than any of its predecessors, as by reason of the fact that it was based throughout on sound engineering principles. So, too, the more purely preliminary stages of the work having passed, the expeditions which under different flags have been engaged in the exploration of Central Africa have come to place an increasing degree of dependency upon the light-draught vessel. Finally, it became apparent from the very inception of the projects for a Cape-to-Cairo railway and telegraph that reliance would have to be placed on vessels of this class to supply, for a time at least, many important links in the chain of communication between the Soudan and the Cape.

Looking in another direction, a glance suffices for some comprehension of the field of usefulness which has been opened for shallow-draught craft by the construction of the Trans-Siberian Railway system. Much of the material for the construction of the line has been transported by river steamers and barges constructed especially for the work, and although the final completion of the road may

abolish the present vocation of many of these boats as ferries on the direct and main line of freight and passenger transportation, they will yet find places as pioneers in the traffic of the new arteries of trade which the railroad will open up. The policy of the "Open Door" in China and the east would seem to insure a great future for the light-draught vessel in Asia. Her rivers are well suited to this class of craft—are, in fact, suited to no other—and the fuel supply and other factors to be taken into consideration offer no insurmountable barriers to their successful operation, while the profits in sight would seem to justify far greater risks than will be necessary.

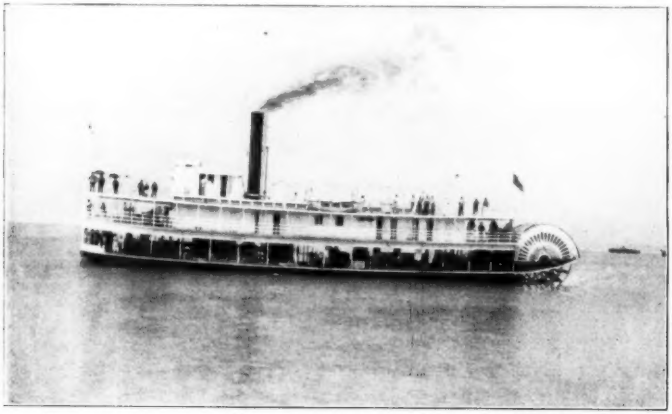
In America, also, events have seemingly conspired in the creation of circumstances favorable to the development of this branch of marine engineering. Prominent among these might be classed the Alaskan gold excitement and the Spanish-American war. Some idea of the demand for light-draught steamers, induced by the opening of the gold fields in the most northerly possession of the United States, may be imagined when it is stated that ship-yards on the

OHIO RIVER STEAMER CITY OF CINCINNATI.
307 feet long, 40 feet beam. Built at Howard's Ship Yard, Jeffersonville, Ind.

Atlantic and Pacific coasts, the Great Lakes, and the Mississippi river were engaged simultaneously upon the construction of craft designed for Yukon river navigation. The war in the Philippines and the acquisition of other new possessions resulted in an imperative demand for light-draught gunboats and steamers for war and commercial service on their rivers. In the case of the former the exigencies of

the situation in some instances necessitated the purchase of old vessels to meet immediate needs, but a majority of these will doubtless be replaced by vessels embodying more modern ideas of construction as soon as opportunity will permit.

The advent of steel hulls in increasing numbers on the Mississippi and other inland rivers of the United States has not been without effect, and the field for high-class river craft would seem to be undergoing a continual betterment. As the development of Canada progresses, constant additions are being made to the fleet of light-draught steamers in service on her inland lakes, some of the vessels being built in Great Britain and others on the western side of the Atlantic. In South and Central America there is a nearly parallel growth, and here a natural inclination to rely chiefly upon light-draught steamers for purposes of transportation is very often coupled with necessity, owing to the character of the country. The trend of events, is however, well indicated by the fact that more orders for shallow-draught craft have come from South and Central American countries during the past half decade than in double that period at any time previously. Build-

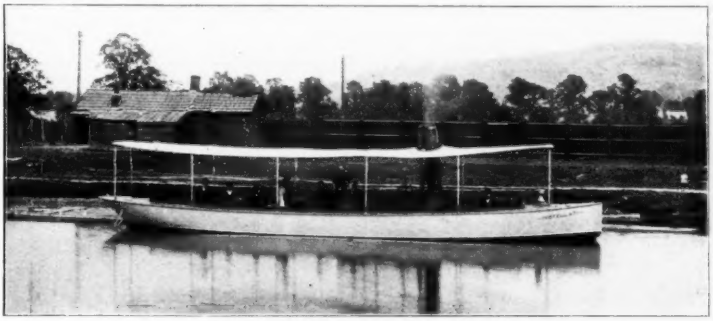


STERN-WHEEL FREIGHT AND PASSENGER STEAMER FOR THE ORINOCO RIVER, VENEZUELA.
Built by the Pusey & Jones Company, Wilmington, Delaware.

ers in the United States and Great Britain have shared in these commissions.

There are three types of shallow-draught steamers—the stern-wheel, the side-wheel, and the ordinary propeller type. Despite the fact that in boats of this class both speed and carrying capacity must of necessity be sacrificed to draught, something may be said in favor

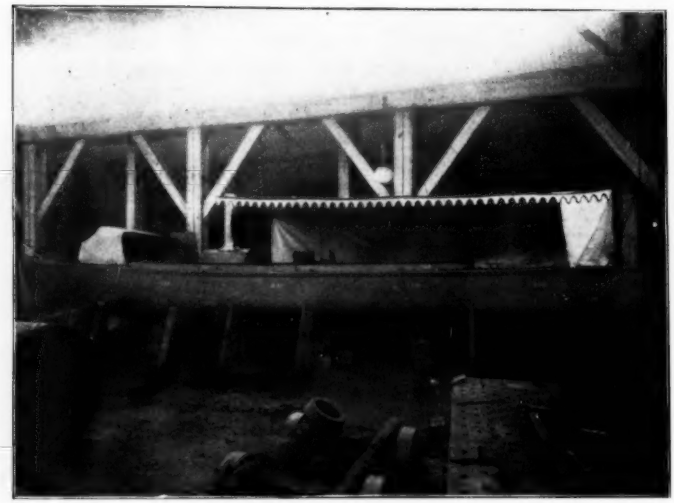
of each of the three types mentioned. The desire for slight immersion makes light construction throughout a prime requisite. This end is kept in view, not only in the case of the material put into the hull and in the distribution of machinery weights, but in the case of the machinery itself. Thus stern-wheel vessels are almost invariably



TWIN-SCREW LIGHT-DRAUGHT STEAM LAUNCH.
Built by Summers & Scott, Gloucester.

recommended by the builders when a steamer is desired for exploring purposes, or for the navigation of rapids or narrow rivers—not so much because of the smaller breadth of hull as by reason of the simplicity of the slow-moving machinery and the fact that the location of the engines and boilers at the extremities makes it readily possible to distribute their weight over the hull by means of struts and bracing. The service in which some light-draught vessels are employed makes it expedient to equip them with locomotive-type boilers arranged to burn wood fuel; but in various vessels of the shallow-draught class in different parts of the world are to be found almost every imaginable kind of boilers, fitted for the consumption of the different species of fuel. The introduction of the water-tube boiler has been an important factor in more recent efforts to produce slight immersion, and present indications are that the utilization of its unique qualifications in this respect may be still further extended.

One of the surprising features of the construction of light-draught steamers is the rapidity which in almost all cases characterizes the building operations. Some of the vessels turned out at British yards for service in Africa and Russia were constructed, taken apart, shipped to their point of destination, and re-erected all within less than a year's time. The speediness of this work is shown in a new light by the record of one ship-yard on the Ohio river, which has,



LAUNCH FOR LAKE NYANZA, AFRICA.

42 feet long, 7 1-2 feet beam, speed 11 knots. Built by Thornycroft.

since its establishment a little more than half a century ago, turned out upwards of seven hundred vessels. That quick completion is not, however, secured at the sacrifice of efficiency, is proven by uncontrovertible evidence. The best of this is found in the fact that seldom, indeed, has any difficulty been encountered in putting together the vessels shipped in sections. Take, for instance, the case of the Union Iron Works of San Francisco, which some time ago filled a foreign order for eleven barges. All the material was gotten out from patterns and only one barge was put together for purposes of verification. The remaining ten were put together at their destination, and in no case was any difficulty encountered.

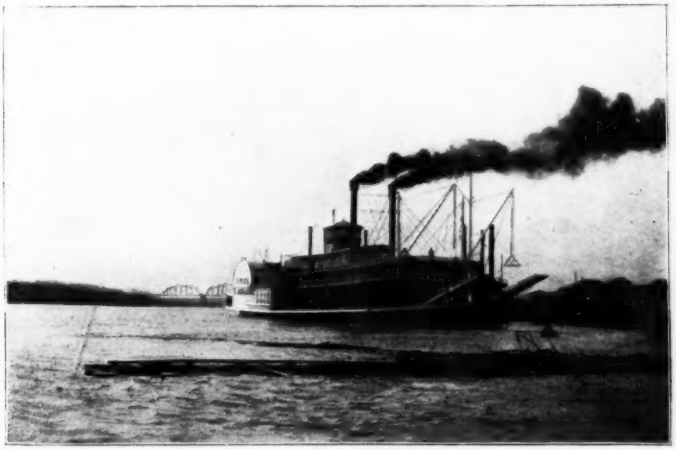
To take up first the subject of light-draught vessels on the Mississippi and other inland rivers of America, it may be stated that the fleet in service on these waters comprises no less than fourteen hundred vessels, all of which, of course, are of the class mentioned. There are on the rivers about a dozen ship-yards of some reputation and they turn out each year more than two hundred vessels, the aggregate value of which is not far from two million dollars. Nor can the great fleet of vessels on the rivers, controlled by the United States government, be overlooked. It comprises lighthouse tenders, survey boats,

pontoons, barges, and towboats, almost all of them being under the control of the Mississippi River commission.

Ship-building practice on American inland rivers involves a pretty close adherence to precedent. Save in the matter of interior furnishings, one of the wooden steamers of given design is pretty much like another. Moreover, there has been almost no change in the general design in more than a score of years. Contemporary interest, therefore, is confined largely to the transition from wood to steel hulls which is now in progress.

How recent is the advent of steel plates for hull construction in the river ship-yards of America will be understood when it is stated that the Kate Adams, the first steel-hull side-wheel packet steamer built for passenger and freight service on these rivers, was not completed until late in 1898. The Adams, which was built at the yard of Capt. E. J. Howard, of Jeffersonville, Ind., for the Memphis & Arkansas City Packet Company, of Memphis, Tenn., may be taken as thoroughly representative of the most approved modern type of vessel for American inland-river navigation.

As strength had all along been sacrificed in the large wooden steamers to secure lightness of draught, the results from the adoption of steel in the hull of the Adams were naturally waited with no little

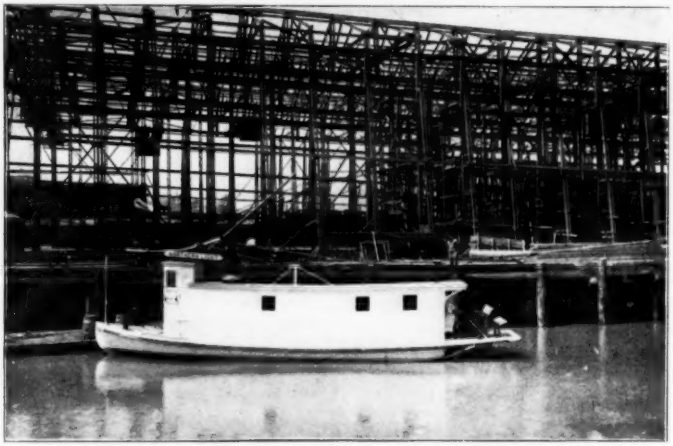


STEEL SIDE-WHEEL STEAMER KATE ADAMS, FOR FREIGHT AND PASSENGER SERVICE ON THE MISSISSIPPI RIVER.

250 feet long, 41 feet beam, 7 feet depth of hold, 3 feet 3 inches draught. Built at Howard's Ship Yard, Jeffersonville, Ind.

interest. Indeed, some of the builders on the river did not refrain from expressions of skepticism—or of incredulity—as to the advantages claimed for steel. Naturally, therefore, no little surprise was manifested when, after the new steamer had been completed and gone into commission with her complete outfit on board, her draught was found to be only 3 feet 3 inches, whereas two boats having wooden hulls, built at the same yard, of the same general dimensions and exactly the same engine and boiler power, each showed under similar conditions a draught of 4 feet 4 inches.

The Kate Adams is 250 feet in length, 41 feet beam, 7 feet depth of hold, and 5 feet sheer, and is fitted with three fore-and-aft and

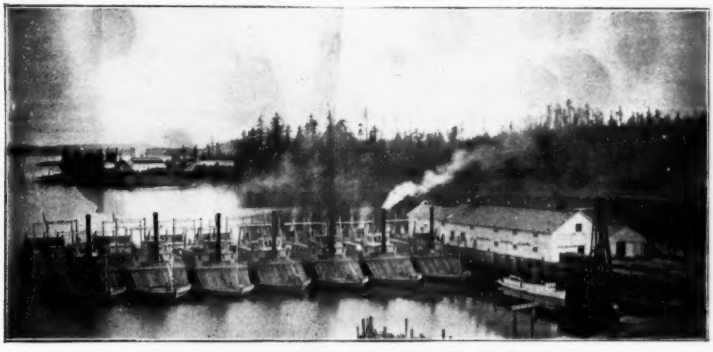


MISSIONARY BOAT NORTHERN LIGHT, FOR THE YUKON RIVER, ALASKA.
Built by the Union Iron Works, San Francisco, Cal.

five athwartship watertight bulkheads. The hull plating on the bottom and sides is of 5/16 inch steel and the entire hull is double riveted, the cavils, bitts, and knees being of iron and steel. The engine is of 24 inches diameter of cylinder and 8 feet 9 inches stroke, and steam is supplied from four steel boilers 48 inches in diameter by 28 feet in length. A "doctor" is fitted for supplying the boilers, and there are also auxiliary pumps and injectors, an auxiliary boiler for electric-light and heating purposes, and a patent steam filter for filtering all the water used on board the vessel. The steamer cost $90,000; she has a freight-carrying capacity of 600 tons, and in regular service she travels a thousand miles each week, making during the journey more than one hundred and eighty landings.

FLEET OF STEAMERS FOR THE YUKON RIVER ON THE STOCKS.
Moran Brothers' Company, Seattle, Wash., April, 1898.

Of the light-draught vessels for service on the Alaskan rivers there have been constructed many types, but all of them embody more or less of the characteristics of the river steamers on the Mississippi. One of the designs is that followed by the Moran Brothers Company, of Seattle, Wash., in the construction of a fleet of twelve wooden steamers for employment in the traffic on the Yukon river. Something of the staunchness of the craft is suggested by the fact that they weathered successfully the rough voyage from Puget Sound to St. Michaels, Alaska. The steamers—identical in every respect—are 175 feet in length, 35 feet beam, and 6½ feet depth of hold. They are stern

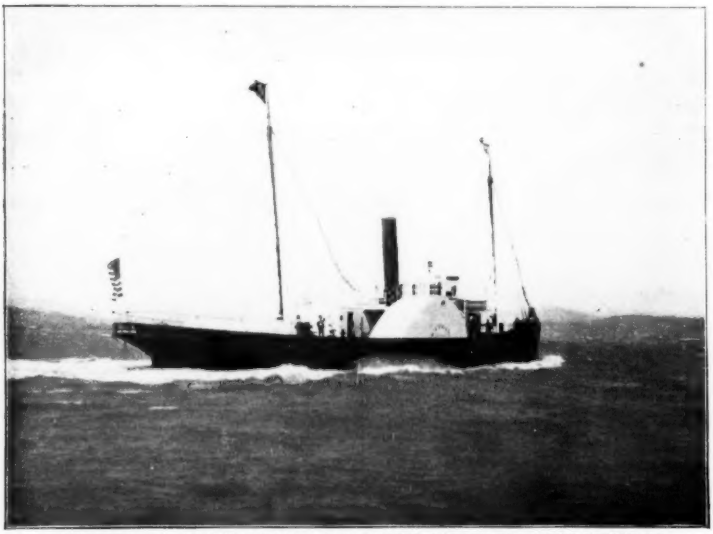


FLEET OF STEAMERS FOR THE YUKON RIVER, ALASKA.
Each is 175 feet long, 35 feet beam, 6 1-2 feet depth of hold, and draws 4 feet with 400 tons cargo. Built by Moran Brothers' Company, Seattle, Wash.

wheelers, with engines having cylinders 20 inches in diameter and 7 feet stroke. Steam is supplied from three cylindrical tubular boilers, 44 inches in diameter by 16 feet long. The steamers have all modern equipment, including an electric-light plant, and each vessel has a capacity of 400 tons on 48 inches draught.

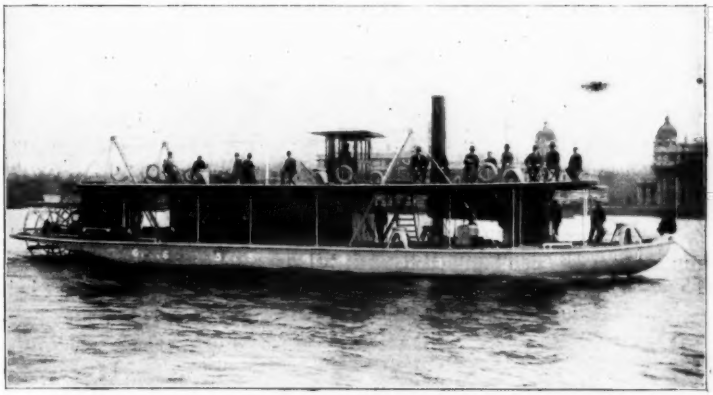
Among the achievements in the line of ship-building for the Alaskan trade there stands out prominently the accomplishment of the Union Iron Works of San Francisco, which, during the latter part of 1898, constructed complete in 120 days a steel side-wheel tug boat of light draught for the service of towing the barges of the Alaska Commercial Co. between the mouth of the Yukon river and St. Michaels. This tug, christened the Saidie, is 157 feet 6 inches over all, 150 feet water line, 30 feet beam, 8 feet depth, and has a draught of 3 feet 4 inches. She is fitted with compound engines of 300 horse power, with cylinders 16 and 32 inches in diameter and 5 feet stroke. The wheels are 17 feet 6 inches in diameter, and the engines make, full open, 28 revolutions per minute. The tug has on several occasions developed a speed of 11 knots.

Among the European builders of light-draught steamers a promi-



LIGHT-DRAUGHT STEAMER SAIDIE, FOR TOWING BARGES FROM THE YUKON TO ST. MICHAELS.

157 feet 6 inches long, 30 feet beam, 8 feet moulded depth, and 3 feet 4 inches draught; speed 11 knots. Built by the Union Iron Works, San Francisco, Cal.



GUNBOAT FOR THE BRITISH GOVERNMENT, FOR SERVICE ON THE ZAMBESI.

Length, 77 feet, beam 18 feet, draught with steam up 18 inches; speed 10 miles. Built in floatable sections; ordered April 1, 1890, and completed May 3, 1890.
Yarrow & Co., London.

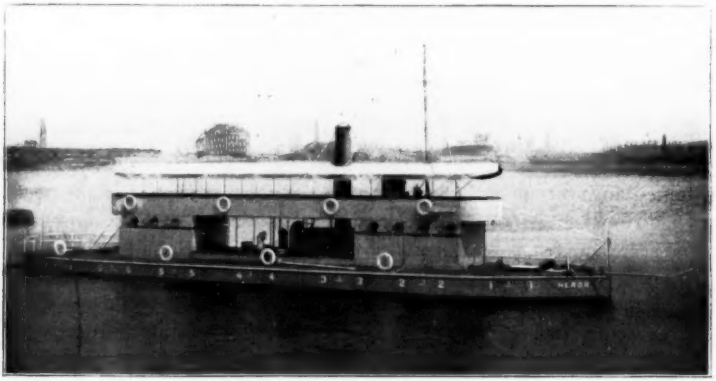
nent place must be accorded to Yarrow & Co., London, who have attained an international reputation by the construction of high-speed torpedo boats. Among the more interesting craft of this character which Yarrow & Co. built, as far back as 1877, was a shallow-draught stern-wheeler for the Hudson Bay Company. It was 120 feet in length and 24 feet beam, and had a draught of only 13 inches with twelve hours' fuel on board. With 70 tons of cargo the draught was 2 feet 6 inches. The hull was divided into fourteen compartments.

A few years later the British builders turned out two stern-wheelers for the conveyance of mails on the Magdalena river in the United States of Colombia, South America. These vessels were 130 feet long and 28 feet beam, and drew 12 inches of water with steam up, but without cargo, and 24 inches with 90 tons of cargo on board. The vessels were engined for 400 horse power each and developed a speed of 16 miles per hour. The seeming general preference for stern-wheel steamers, in the face of the fact that many experiments have proven that there is no perceptible difference in speed between a stern-wheeler and a side-wheeler of the same dimensions and power, is attributable to a number of causes. The stern-wheeler has a decided advantage in shooting rapids; the wheel is not so likely to be damaged by floating logs; and finally, it is available for service in narrower streams.

In the early eighties Yarrow & Company delivered to the Belgian

government the steamboat Le Stanley, designed for service in an African expedition headed by the well known explorer whose name it bore. Five hundred natives were required to transport the vessel overland. It was composed of six oblong pontoons of galvanized steel, each 18 feet long by 8½ feet in width. The engines had one cylinder on each side of the vessel, the diameter being 10½ inches and the stroke 2½ feet. Le Stanley had a mean draught of 14 inches, and a speed of 10 miles per hour could be maintained.

Stern-wheel steamers of English construction have played a most important part in all the Nile expeditions, and have in many cases passed cataracts and waterfalls the navigation of which was regarded as impracticable by the military authorities. In one case, one of these



A SHALLOW-DRAUGHT GUNBOAT

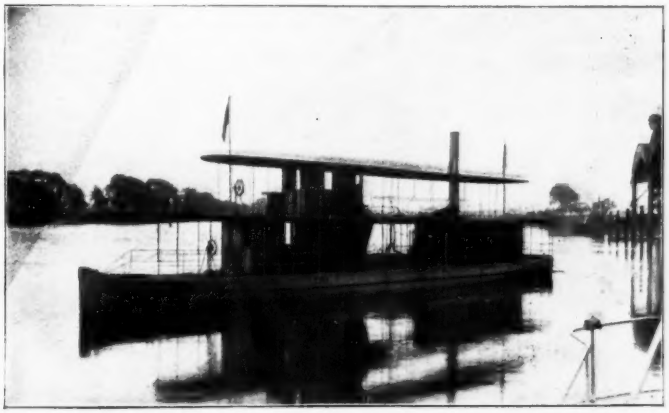
Length 100 feet, beam 20 feet, draught carrying 25 tons, 1 foot 11 inches; speed 10 1-2 miles. Built by Yarrow & Co., London.

boats for Egyptian service was completed in exactly seventeen days. Some of the vessels shipped to the Nile have been used as gunboats, being fitted with rapid-fire guns and shot-proof houses, and others have been employed for transport purposes.

Shallow-draught vessels have been a specialty also with Messrs. John I. Thornycroft & Co., from whose works at Chiswick, London, many interesting craft have been turned out for service in all parts of the world. In 1881 they built for the Baptist mission on the Upper Congo, Africa, the Peace—a boat designed for a draught of water of but one foot when loaded with necessary fuel and stores and carrying four persons. The Peace was propelled by two turbine propellers, which were above the water line for one-quarter of their diameter.

In her trial trip on the Thames, she attained a speed of 12 miles. She was taken apart and shipped in a number of small packages, so as readily to be carried overland and re-erected by the natives on the waters in which she was intended to work. She had a water-tube boiler, which was in use on the steamer for six years, and afterwards furnished power at a land station.

The Peace proved her value in the exploration of some of the tributaries of the Upper Congo. The Congo Free State, requiring a light-draught vessel at one time, requisitioned this steamer as the only one available. To avoid being thus cut off from communication with their stations on the Congo, the Baptist mission ordered a second vessel, the Goodwill, of somewhat greater carrying capacity and draught.

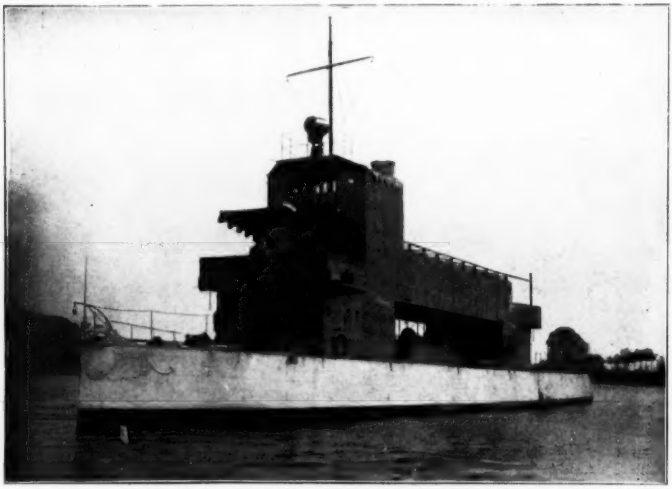


STEAMER GOODWILL, BUILT FOR THE BAPTIST MISSION ON THE CONGO.

84 feet long, 13 feet beam, 2 feet 2 inches draught; speed 10 1-2 miles. John I. Thornycroft & Co., Chiswick, London.

The vessel was built in 1891, and was equipped with a water-tube boiler, two turbine propellers, and compound engines; one propeller being worked by the high-pressure cylinder and the other by the low-pressure cylinder. She gives sleeping accommodations to eight persons, and draws 2 feet 2 inches with 13 tons of cargo. The river gunboat Melik, built by Thornycroft for service on the Nile, is a type of a powerful vessel of this class, being somewhat heavier and of slightly greater draught than the original patrol vessels built in 1885 for the relief of Khartoum. These had a length of 140 feet, a beam of 21 feet, and a draught of 1 foot 4½ inches forward and 1 foot 10½ inches aft. The dimensions of the Melik are: length, 145 feet; beam,

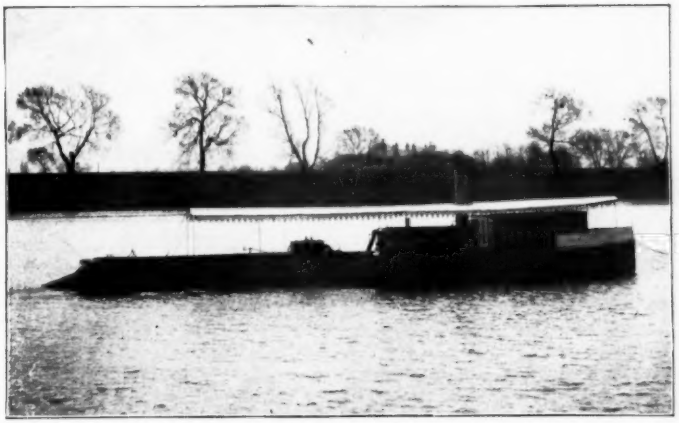
24 feet 6 inches; draught, 2 feet. She makes a speed of 14 miles with an indicated horse power of 457, and her load is 35 tons. All the plating over the machinery, and that of the upper decks, block houses, etc., is of chrome steel. Arranged as a passenger or cargo steamer instead of a gunboat, she would carry a load of 40 tons at the same draught and speed. The launch Sapucahy Mirim is a steam launch for Brazilian waters, built by the same firm, and made in five sections for transportation. She has a length of 56 feet 8 inches, a beam of 9 feet 11 inches, a draught of 1 foot 3 inches, and carries a load of 1.3 tons at a speed of 15 miles with 122 indicated horse power.



H. M. S. MELIK—A POWERFUL NILE GUNBOAT.

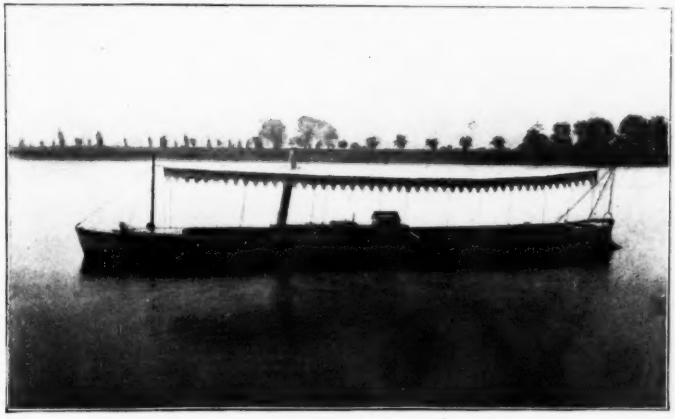
145 feet long, 24 1-2 feet beam, 2 feet draught; speed 12 knots. Built by John I. Thornycroft & Co., Chiswick, London.

Under trial, she towed a flat-ended barge containing 14 tons of ballast at a speed exceeding 8 miles per hour. The launch for the Magdalena river, illustrated on page 200, is a larger vessel 78 feet long, 12 feet 2 inches beam, and 2 feet draught, with compound surface-condensing engines of 190 indicated horse power under moderate forced draft, giving her a speed of 15 miles with 4.3 tons' load. She has three rudders, two at the stern and one forward. The Bygunbary is an example of the small steam launch, built for the Hoogli river. She is 30 feet 8 inches long, 5 feet 6 inches beam, draws 11½ inches with a load of ¼ of a ton, and makes 11¼ miles on 13 indicated horse power. Her engines are of high-pressure non-condensing type.

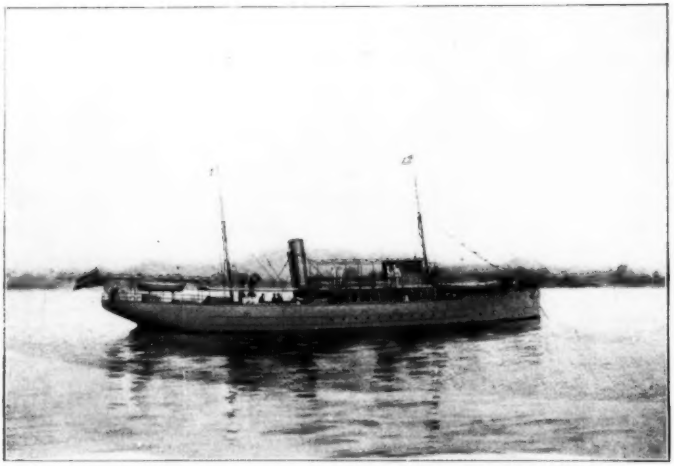


SHALLOW-DRAUGHT LAUNCH SAPUCAHY MIRIM, FOR BRAZILIAN WATERS.
Length 56 feet 8 inches, beam 9 feet 11 inches, draught 1 foot 3 3-4 inches. Speed 13 miles. Built by Thornycroft.

The Sentinel Works at Glasgow, Scotland, of which Alley & Maclellan are proprietors, is an institution which has constructed some highly interesting examples of the stern-wheel steamer. Among the earliest of these vessels constructed at the Glasgow works were several steamers designed for ferry service in India. These vessels are 110 feet in length, 23 feet beam, and 4½ feet depth. These boats,

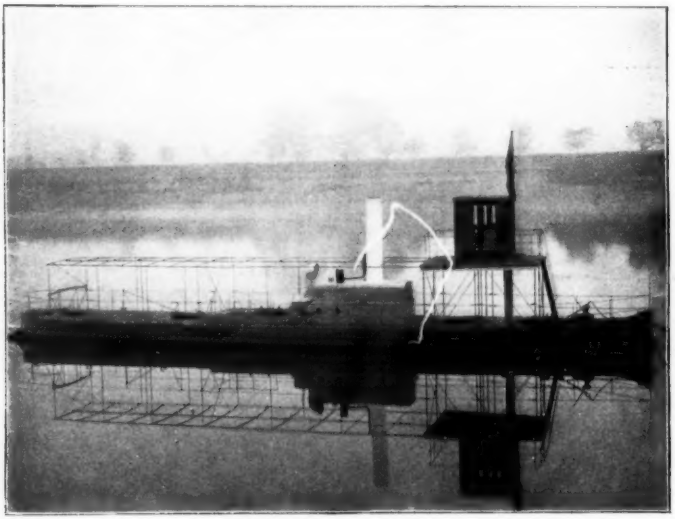


STEAM LAUNCH BYGUNBARY, FOR THE HOOGLI RIVER, INDIA.
Length 30 feet 7 inches, beam 5 feet 6 inches, speed 10 miles. Built by Thornycroft.



MISSION STEAMER CHAUNCEY MAPLES, FOR LAKE NYASSA, AFRICA.

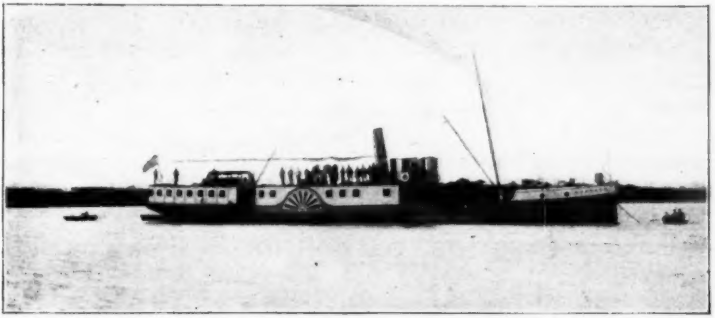
126 feet 6 inches long, 20 feet beam, 8 feet 6 inches moulded depth, 6 feet draught. Burns wood fuel. Built complete, taken down, and shipped in sections.
Alley & Maclellan, Glasgow.



STEAM LAUNCH FOR THE MAGDALENA RIVER.

78 feet long, 12 feet beam, 2 feet draught. Built by John I. Thornycroft & Co.

with steam up and fully loaded, drew only about 2 feet of water and steamed on their trial trips 12 miles per hour. The firm also constructed, some years ago, four side-wheel paddle steamers for carrying passengers and towing barges on the Indian rivers. A paddle steamer, the Lady Margaret, constructed for passenger service on the English Channel, although of 144 feet in length over all by 32 feet beam, draws only 4 feet when fully loaded. Other paddle steamers turned out at the Glasgow yards for service in foreign waters—vessels 168 feet in length—have shown a draft of less than 2½ feet with steam up, fully equipped, and with stores, fuel, etc., on board. Other steamers of similar design, but a few feet shorter, have registered a draught of exactly 2 feet when loaded with 80 passengers, 20 officers and men, and with 10 tons of fuel aboard. The paddle steamer



STEAMER GUANACO, FOR FREIGHT AND PASSENGER SERVICE ON THE RIVER URUGUAY.
149 feet long, 24 feet beam, depth 5 feet 3 inches, draught 2 feet 6 inches. Built by Alley & Maclellan, Glasgow.

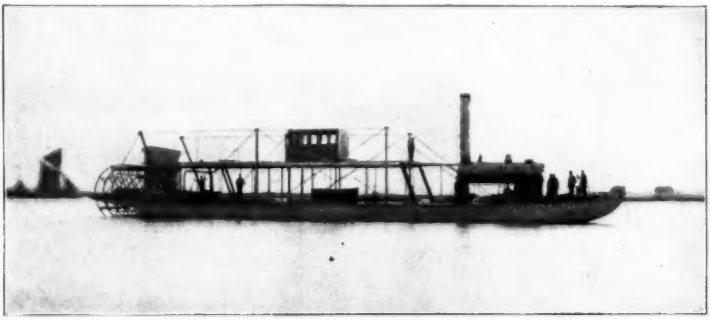
Guanaco, constructed for passenger and cargo service on the river Uruguay, South America, has a length of 151 feet and the loaded draught, with 80 tons of cargo and 100 passengers, is 36 inches. The Guanaco is fitted with compound engines having cylinders 16 and 31 inches in diameter and 40 inches stroke, to which steam is supplied from a boiler of the locomotive type having a heating surface of 934 square feet and suitable for a working pressure of 130 pounds per square inch.

Of the screw steamers from the Sentinel Works decidedly the most interesting is the Chauncey Maples, designed for service as a mission steamer on Lake Nyassa. The vessel is 126 feet in length over all, 20 feet beam, 8 feet depth, and 6 feet draught. She is fitted with compound engines, the cylinders of which are 11 and 24 inches

in diameter and 18 inches stroke. The boiler, which is arranged for wood fuel, is of the locomotive type, having 800 square feet heating surface and a working pressure of 150 pounds per square inch. The vessel was erected complete in the Glasgow yard, all the machinery, etc., being fitted on board, and was then taken apart and shipped to Chindi and from thence reshipped to the lake. For a considerable part of the distance the pieces had to be carried by native carriers. Another similar but somewhat larger screw steamer was shipped in sections to Hong Kong and there re-erected and engined.

Both the French and Russian governments have gone away from home for shallow-draught steamers and in each case have secured vessels that are close copies of those constructed for the British Admiralty. The most interesting of the vessels constructed for the Russian authorities is a stern-wheeler of 100 feet length, which is capable of carrying an armament weighing 7 tons and fuel for 12 hours, steaming on a draught of less than 18 inches. The vessel made 11 miles on trial. The Opale, constructed for the use of the French troops in the expedition against the Dahomeyans in Africa, was a very similar boat and was proven to have deck space for the conveyance of 400 soldiers.

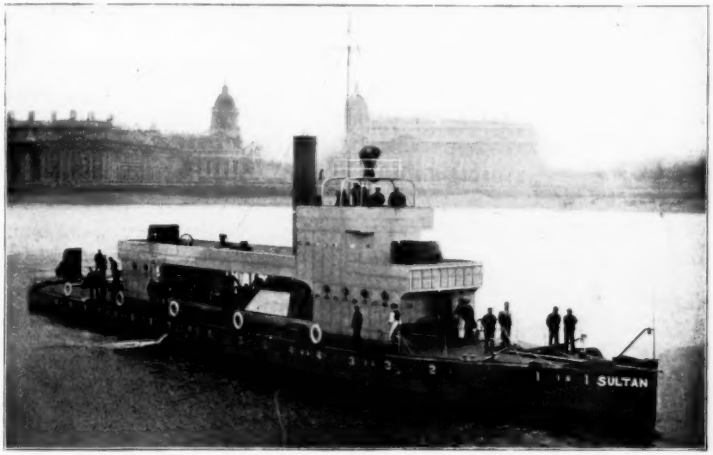
The latest approved practice in light-draught gunboat construction is demonstrated in the Sultan and sister vessels constructed by Yarrow & Co. for the Egyptian government. The Sultan is 145 feet



STERN-WHEEL STEAMER FOR TH E RUSS AN GOVERNMENT.
Length 120 feet, beam 22 feet, draft with 80 tons cargo, 3 feet. Speed 11 miles. Built by Yarrow & Co., London.

in length and 24½ feet beam. The hull proper is 6 feet in depth, and carries a superstructure. The draught, with 35 tons on board, is 2 feet. The hull is built in eleven sections which are bolted together.

The vessel is fitted with two pairs of compound-condensing engines driving twin screws. The engines are capable of developing 600 indicated horse power, and the boat made on trial a speed of 13 miles



SHALLOW-DRAUGHT GUNBOAT SULTAN, FOR THE EGYPTIAN GOVERNMENT.

Length 145 feet, beam 24 feet 6 inches, draught carrying 35 tons, 2 feet; speed 13 miles on a two-hour's run Built in floatable sections. Yarrow & Co., London.

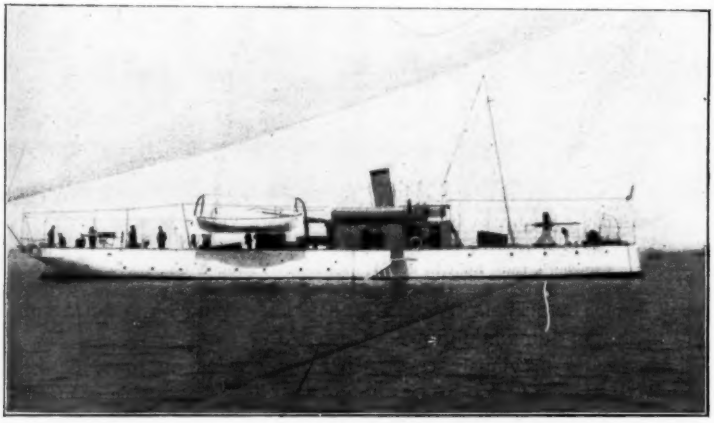
per hour. The armament consists of two 12-pounder rapid-fire guns and a Maxim automatic gun.

All vessels previously constructed for service on the Nile had been stern-wheelers, but it was found that vessels capable of carrying guns of greater power at a higher level would be very desirable, and accordingly Sir William White, who, by the way, has always taken a great interest in shallow-draught vessels, designed the class above described. In these vessels the depth of the hull enabled the engines to be placed below deck, while the boilers, which extend above, are protected by a low superstructure.

The introduction of ordinary screws was, of course, out of the question; accordingly, two tunnels were raised in the bottom of the boat aft, and in each of these one of the twin-screw propellers revolves. The screws are 4½ feet in diameter and the tunnels, therefore, extend 2½ feet above the waterline. The working of the screws drives all air from the tunnels and its place is naturally filled with water, and, as the air once expelled cannot get back even into the portion of the tunnels above the water line, the screws are wholly im-

mersed. The superstructure of the Sultan consists of two steel deck-houses, connected by a flying bridge 77 feet long and 13 feet wide, while above this is a bridge deck 14 feet in length and of the same width. Above this is a platform for the search light. The vessels of this class have in an emergency carried fully one thousand troops each.

A very interesting class of vessels is composed of the light-draught gunboats and unarmored vessels which have been added to the United States navy since the Spanish-American war. Some of these vessels are transformed tugs and yachts, but more than a score of them were captured from Spain or purchased by the United States War Department from that country after the cessation of hostilities. These are of the greatest interest by reason of the fact that they were built



U. S. LIGHT-DRAUGHT GUNBOAT ALVARADO, FORMERLY OF THE SPANISH NAVY.
110 feet long, 15 1-2 feet beam, 5 feet 6 inches draught. Displacement 100 tons. Built at Clydebank, 1895.

especially for service on the rivers of the new American possessions, a service for which the United States government will, in all probability, ultimately have to provide more modern craft.

Men in all branches of the ship-building industry, from the naval architects to the builders themselves, are devoting a constantly increasing amount of attention to light-draught vessels. Indeed, the conditions in the new possessions of the United States, outlined above, the opening of the Nile, and the further development of Alaska, virtually necessitate this. Judging from the present outlook, it is not unreasonable to predict that the next few years will witness the introduction of more innovations than the closing quarter of a century.

THE IRON ORES OF THE LABRADOR PENINSULA.

By A. P. Low.

THE present high value of iron and steel, and the consequent activity in the search for and development of new sources of ore, make this a fitting time to call attention to the iron-bearing deposits of the Labrador Peninsula. Our knowledge of these ore-beds is derived from information obtained by exploring parties sent out by the Geological Survey of Canada into this vast and previously unexplored territory. The first mention of these ores was made by Dr. R. Bell in a report on an exploration of the east coast of Hudson Bay, 1877.* In this report he draws attention to thick beds of silicious spathic iron-ore, near the summit of the series of rocks forming the Nastapoka Islands, which stretch northward for nearly 100 miles from Little Whale River on the east coast of Hudson Bay. In 1893 the writer discovered, on the Kaniapiskau branch of the Ungava River, a large area of similar rocks containing a great thickness of cherty carbonates rich in iron, and underlying these considerable thicknesses of magnetite-hematite ores associated with red jasper and closely resembling the hard ores of Michigan, Wisconsin, and Minnesota. The following year a southern extension of this area was discovered on the upper waters of the Hamilton River. In 1895 a thick bed of magnetite, associated with crystalline limestone and pyritiferous, graphitic mica-gneiss, was discovered on the headwaters of the Manicougan River, separated from the Hamilton River area by a great mass of granite.

In 1896 the central area was found to extend northward across the Larch branch of the Ungava River, and the following season deposits of similar ores were discovered along the west coast of Ungava Bay. During an exploration along the east coast of Hudson Bay, in 1898-99, thick beds of magnetite-hematite ore were found underlying the spathic-ore beds of the Nastapoka Islands. The above summary

Canada in the near future seems likely to be no mean rival of the United States in the iron and steel industry. Three great companies, with an aggregate capital of nearly $60,000,000, are already reported to be in the field, with a nickel-steel plant of corresponding size preparing for extensive operations.

It is of particular interest therefore, to present Mr. Low's account of yet undeveloped iron resources in the Dominion. Mr. Low has recently returned from exploring the region and examining the deposits which he here describes.—THE EDITORS.

* Report of Progress Geol. Survey Canada, 1877-78, p. 21c.

BEDDED CARBONATE OF IRON CAPPING CHERTS, DAVIEAUX ISLAND, NASTAPOKA ISLANDS.

shows that on almost every lengthened exploration in Labrador extensive areas of valuable iron ores have been discovered, and with further exploration other areas will doubtless be found, some of which may be accessible enough to make the ore of great commercial value. The central area of iron-bearing rocks is the largest yet found in the peninsula; it stretches in a direction a few degrees west of north, from 54° N. latitude to beyond 58° N. latitude, thus having a known length of nearly 300 miles, while the average breadth is about 50 miles, giving an area of 15,000 square miles, with the iron-bearing strata developed over at least a third of the area. The magnetite area on the Manicougan River forms a band more than 100 feet thick, which may be traced westward from the river 40 miles to beyond the headwaters of the Outardes River. The deposits along the west shore of Ungava Bay have not been sufficiently explored to determine their extent. On the east coast of Hudson Bay the iron-bearing rocks occupy the islands and parts of the coast between Cape Jones and Cape Dufferin, a distance of nearly 300 miles. The cherty carbonates are met with on Long Island and other smaller islands in the vicinity of Cape Jones, on the islands of Manitounuk chain, between Great and Little Whale rivers; also on the Hopewell chain, immediately south of Cape Dufferin, as well as on the Nastapoka Islands, as already

mentioned. The richer magnetite and hematite ores have been seen only on the last named islands.

The series of bedded strata in which these iron-ores occur bears a striking resemblance to the rocks of the iron-bearing formation south and west of Lake Superior; in fact, the resemblance is so close as to be marvelous in formations so widely separated in distance. The formation has an aggregate thickness of several thousand feet. The lowest beds are sandstones and conglomerates, formed evidently from the decay of earlier granites; these beds are followed in ascending order by red and green felsitic shales, dark blue dolomite, sandstones and shales, cherty limestones and black shales, ferruginous cherts, and black carbonaceous shales. The iron ores occur in the ferruginous cherty measures, which, in the central area, have a thickness of 850 feet. The rocks forming the central area and the coastal area of Hudson Bay are practically unaltered, except near their contact with masses of irrupted granite; the beds dip in the central area toward the N. E., or Ungava Bay, the angles of dip being usually under 30°, but the rocks are thrown up into a number of ridges at right angles to the dip by a force acting from seaward, which has buckled the formation and so caused a repetition of the beds in each of the ridges. The same thing has occurred to a minor extent on the coast of Hudson

BEDDED JASPER-MAGNETITE-HEMATITE ORE.
Ford Island, Nastapoka Islands, east coast of Hudson Bay.

Bay. Along the west coast of Ungava Bay a similar horizontal movement of the beds is complicated by intrusions of granite, which have changed the rocks into schists and the iron ores into magnetites similar to those of the Mesabi Range, west of Lake Superior.

On the Manicougan the rocks are surrounded by large masses of granite, which has completely altered them to crystalline limestones and gneiss, even the iron ores being in the form of a gneiss, made up chiefly of magnetite and quartz.

The ores appear to have been originally precipitated from solution in a shallow sea, the most common form of precipitate being a carbonate of iron, which is found throughout the measures associated with

BEDDED MAGNETITE AND JASPER ASSOCIATED WITH CHERTS.
Lantz Island, Nastapoka Islands, Hudson Bay.

cherty carbonates of lime and magnesia in the silicious beds of the middle of the formation. These deposits of spathic iron occur most commonly in patches varying in size from minute specks to masses containing thousands of tons, and some of the silicious beds are largely composed of this ore, making workable deposits from one to ten feet thick. The richer deposits of oxides in the form of hematite and magnetite, or, more commonly, a mixture of both, usually occur near the base of the iron-bearing measures, and may be due to concentration, by circulating waters, of the iron from the leaner beds above, as

THE IRON ORE DEPOSITS OF LABRADOR.

Large deposits are shown by the shaded portions.

is held to be the case in the Lake Superior region; but I think this is not universal, and that in many cases the richer oxide ores may have been originally deposited as such in a manner similar to the deposits of oxides now forming in the lakes north of Three Rivers, Province of Quebec. Whatever their mode of formation may have been, we now find them, where unaltered, occurring as a mixture of hematite-magnetite, in bands varying from less than an inch to several feet in thickness and separated from one another by bands of red jasper, which also varies in thickness; so that, with varying proportions of both, the ore runs from an exceedingly rich one to a lean ferruginous jasper. The total thickness of these measures in the central area is about 500 feet, giving at least 200 feet of workable ore. On the Nasta-

poka Islands the rich iron beds are not so thick, and 50 feet may be taken as the workable thickness of good ore.

The following analyses were made from hand specimens, taken more for geological specimens than for ore samples, and are consequently not as good as might be found in large quantities in the localities from which they were taken, on the Kaniapiskau River. No. 1 is from a specimen of the cherty carbonate ores and may be described as a mixture of siderite and ankerite. No. 2 is from an exposure of 400 feet of the jasper ores, and was largely composed of hematite:

(No. 1.)	Ferric oxide	23.43 per cent.
	Ferrous oxide	21.32 "
	Manganous oxide	1.34 "
	Insoluble residue	6.72 "
(No. 2.)	Ferric oxide	80.17 "
	Ferrous oxide	0.35 "
	Manganous oxide	3.09 "
	Insoluble residue	13.78 "

No analyses have been made of the oxide ores from the other areas, but the following analysis of a carbonate ore from the Nastapoka Islands is interesting on account of the very large percentage of manganese present, which renders it very valuable as spiegeleisen for conversion with richer ores into Bessemer steel:

Metallic iron	25.44 per cent.
Carbonate of manganese	24.00 "

Under present conditions the ores of the interior and Ungava Bay are useless, owing to the lack of railway or other communication. The deposits on the islands of Hudson Bay lie immediately alongside of deep water, and so there would be no difficulty in loading on shipboard, but the long carriage through Hudson Strait and the shortness of the season of navigation (3½ months), are serious considerations in connection with the profitable working of these deposits. No coal exists about Hudson Bay, or in Labrador, and the wood for charcoal would have to be transported from the southern part of Hudson Bay to allow of smelting in the vicinity of the mines. The only supply of fuel in the neighbourhood is found in the great masses of driftwood on the islands and shores of the bay, and it is doubtful if this would answer the purposes of smelting. There are excellent water-powers in the neighbourhood, which might be used if a cheap method of electric smelting were discovered; otherwise it seems as if this area, along with the others, may long remain one of the undeveloped resources of the country.

WORKS MANAGEMENT FOR MAXIMUM PRODUCTION.

By J. Slater Lewis.

IT should be obvious that the advantages to be derived from the adoption of modern plant and organisation may be more than neutralized by the cost of labour or materials, by the action of trades-unions, municipalities, or governments, or by circumstances peculiar to local or national life in England and elsewhere. Perhaps in course of time many of these factors may have a universal standard of value, when all manufacturers will be on a fairly equal footing—except, perhaps, in regard to freights and packing charges, which will always remain in favour of those who can deliver their goods quickly without costly packing and at nominal transport rates. For the purpose of to-day, however, we must, in considering the profitable introduction of specialised machinery, reckon with things as they are, making reasonable allowances for future contingencies.

Some may ask: "What have all these subjects to do with the profitable introduction of specialised machinery?" I would reply: "Just as much as the theoretically correct disposition and arrangement of all the parts of a steam-engine or a dynamo have to do with the efficiency and economical manufacture of the finished article." Let any one item be wrongly disposed towards another, and instead of a good machine you have a bad one. But some may say: "Is it not then, altogether a question of technical education?" Well, technical education alone is not going to wipe out those engineers who have found the careful collaboration and dissection of commercial facts and probabilities the principal desiderata in locating, founding, organising, and controlling their works. Commercial traffic takes the line of least resistance, and neither technical education, specialised machinery, nor anything else will enable a man in India to make money by manufacturing snow-balls for Icelanders. A man may build a shoe factory in China, where labour is plentiful, and he may

Mr. Slater Lewis' concluding paper, which gathers together and fastens in one center the lines of argument in his preceding articles, has been delayed in its appearance by his much regretted ill health.

Circumstances, however, give an unusual keenness of interest to the appearance of the paper at this moment. The United States have just felt the menace of a conflict like that which convulsed England's engineering industries in 1897. The lessons of Britain's experience are invaluable to those who are meeting the conditions through which she so lately passed. The outcome of the American situation is of the highest interest to European com-

equip that factory with automatic machinery and every appliance calculated to cheapen production; still, if he had to buy his leather in America and find a market for his goods in France, where a hostile import tariff was in existence, he would find it hard work indeed to compete successfully with the Frenchman, who, although his works and plant and commercial organisation were not in accordance with modern thought and ideas, had leather in abundance at his door and a ready market for his shoes when he had made them.

Let us therefore analyse very briefly the main practical considerations lying around the subject before us.

TRADE UNIONS.—These must be seriously reckoned with in the consideration of the subject, since the effect of their operations in various countries differentiates to a very important extent and consequently affects prices. As, therefore, trade unions have such an important bearing upon trade, it may lead to a better understanding if we trace briefly their origin.

We know that enterprising people prefer to *lead* and to carry others with them by the process of induction. We know also that others of less enterprising natures prefer to *follow,* and to be dragged along by the force of circumstances. Not many decades ago the bulk of the masters in Great Britain believed, unfortunately, in the short-sighted policy of regarding their men as so many machines, unworthy altogether of human consideration. Questions of hygiene, such as sanitation, light, and warmth, never concerned them, much less did questions of instruction. To lower wages and to keep their men in a state of subjection was the ideal principle of their profession. Any calculation with a view to proving the wisdom of providing for the comforts and the social and moral well-being of their men was beneath contempt. And what was the result? The best-skilled men, discouraged by that sort of thing, sought wider spheres, where their energies and intelligence not only met with due reward but have been the means of bringing home to us, and in very drastic form, the folly

petitors. In view of the inevitable tendency toward apparently opposing organisations of employers and workmen, in both countries, it is indispensable to study the means by which such organisations may be brought into co-operation and harmony, instead of antagonism and discord. Trade unions, with all their defects and arrogance, are admitted to have wrought much that is intrinsically good. Employers' unions, directed with the broader view which is, or should be, theirs, should be yet more beneficent and freer from mistakes of motive or abuses of power. The movement, which was primarily militant, should be eventually all efficient in putting an end to strikes and bitterness.

The able and admirable paper by Mr. H. W. Hoyt, which leads this number of THE ENGINEERING MAGAZINE, will be read with extreme interest. It defines the present situation in the United States and the purposes which dominate American industry in the adjustment of relations between employers and the unions.—THE EDITORS.

of attempting to stem the tide of progress. It is, therefore, to the principles of that ancient species that we are indebted for trade unions. Revolutions are brought about by oppression and the grindstone of tyranny—never by trusting the people, nor by making a cringing community into full-blown men. America has, comparatively speaking, had little trouble with trade unions, all because careful observation, enlightened management, and scientific enquiry have taught her that urbanity of motive and cosmopolitanism of thought produce in the long run the best results, financial and otherwise.

However, trade unions having established themselves in Great Britain, what happened? English employers not only affected to ignore their claims, but had a sublime disregard for any kind of defensive organisation. It was only after enormous mischief had frequently been done to trade by strikes, and when business became almost impossible, that they suddenly and simultaneously discovered they had too long ignored the fact that an organisation for the protection of employers was of vital importance. Trade unions took advantage of the position in many ways and were busily engaged in the operation of forcing the manufacturers' hands by sectional tactics, which individual masters were powerless to cope with. A combination of the engineering employers and a costly lock-out became inevitable. Everybody remembers it. But it has put the British engineering trades on a sounder footing and has enabled manufacturers to begin the process of measuring swords with their foreign competitors. And, further, it has led to a better understanding between master and man, and has removed much of the deadly friction which hitherto existed. Whether this happy result in any way accounts for the abnormal success of the country during the past two years I cannot say, but the imports and engineering exports have beaten all previous records, and the revenue of the country is millions of pounds in excess of any previous financial period. Whatever may be said to the contrary, there can be no doubt that masters' unions and men's unions are alike desirable and necessary for the regulation of the labour traffic, and those who think otherwise only deceive themselves. But what the British manufacturer really requires is a levelling of wages the whole world over, and he should pray most earnestly for the success of the trade unions in those countries which do not at present enjoy the attentions of the representatives of those institutions. However, what we have to ask ourselves at the moment is this: "Is it possible under the present conditions of labour, or desirable under the prospective conditions attaching to trade unions, for Great Britain

to attempt to manufacture goods profitably, by the introduction of specialised machinery, in competition with America and the Continent?"

THE COST OF LABOUR.—Between the *nett cost of labour* and the *hours of work* in America and England there is perhaps not much difference, but that there is a striking difference in the Continental practice no one will deny, inasmuch as the "working-day" on the eastern side of the Channel is much longer, and the rate of pay much less than obtains in either of the other countries mentioned. Perhaps some day our neighbours may be able to place a correct estimate upon their services, but for the moment their cheap labour and long hours tell heavily against English engineers.

Many arguments have been adduced by the workman's representatives with a view to proving that the British workingman is, after all, no better off than his friends on the Continent—in other words, that the British manufacturer has nothing to grumble about. It is, indeed, often contended that the ratio of wages earned to the actual net value of work performed is no greater in one case than the other. My experience, however, satisfies me that the contrary is the fact, and as cheap labour affects all industries, it follows that coal, coke, iron, timber, and other commodities will be affected favourably for the manufacturer, and that in consequence our Continental friends can cut prices below the British remunerative limit and yet secure a large share of profit for themselves.

Englishmen used to meet that particular aspect of the subject by the "made in Germany" excuse, but sarcasm soon ceases to have an effect when people's pockets are touched. The phrase answered its purpose for awhile, but the superior class of goods now manufactured on the Continent has turned the tables completely and "made in Germany" is now regarded as a valuable national trademark—one, in fact, in which Britishers would fain have never heard of!

THE COST OF MATERIALS.—The cost of raw materials is, more often than not, a matter of paramount importance to the manufacturer and cannot be ignored in the consideration of the question before us. It will be obvious that the manufacturing engineer who uses large quantities of heavy materials should be within the shortest possible distance of the producer, and should have railway sidings and the best facilities and appliances for the efficient handling of the material when it arrives at the works. If only small quantities of light materials are required, that particular feature of the internal economy of the establishment may be disregarded in favour of more important

ones—such as access to suitable labour, water power, and good markets.

"PROTECTING" LABOUR.—The British government and the British municipal and country authorities, not content with the many burdens which manufacturers have to bear, must, forsooth, impose labour and fair-wage clauses upon contractors, which, when reduced to first principles, will not bear scrutiny at the hands of even the most thick-headed philosopher. For instance: "standard rates of wages" must be paid to all men employed upon a number of dynamos being made, say, for the British War Office. Now, if the *whole* of the *raw materials* used in the building of those dynamos were produced by the dynamo-maker himself, and were not purchased from outsiders, there would be some sense in the system of preventing "sweating," but no manufacturing engineer is independent of outside manufacturers. All have to buy something from the outsider, and here we often find the "sweater" in his most heinous form. He stands little chance of being molested. It is not the contractor of first instance, he who is compelled to pay standard rates of wages and who produces the bulk of his *finished materials* from his own *raw materials*—the sort of man who brings real solid wealth to the people—who gains by these arbitrary clauses, but the contractor of first instance who produces little from the *raw material,* and who buys most of his materials. not, perhaps, from the person whom we may call the contractor of second instance, but from the contractor of the third or fourth instance—those men who are never troubled by public regulations of any kind, and who "sweat" their men and women with callous brutality.

I am quite aware that, legally, permission has first to be obtained to employ the sub-contractor or contractor of second instance, but it is a rule more honored in the breach than in the observance. And what is the result? Why, the contractor of first instance, who buys the bulk of his material from the "sweater," can "wipe out" the genuine contractor, who produces his own goods in the entirety, and who, as the contractor of the first instance, is compelled to pay standard wages to all classes of labour.

The rottenness of such a system of "protection" becomes more pronounced when we ponder over the fact that any article of foreign manufacture will be accepted by these public bodies and paid for without any inconvenient questioning as to rate of wages or hours of labour. This phase of the question needs to be carefully considered in connection with the subject of Works Management for Maximum

Production, since it is rapidly becoming a question not so much of "What *can* we do" as "What *may* we do?"

FREE TRADE *versus* RECIPROCITY.—I do not propose to say much regarding this question, but one thing is clear—that the Americans and all our Continental friends not only have large markets of their own, but a free and open door into the vast English markets. The combination of those two factors is of supreme importance in connection with the subject of "mass production," where quantity and the extent of the field of operations are the very soul and essence of success. The British manufacturer, go wherever he will, is opposed by tariffs not only prohibitive in magnitude but "ad valorem" and hostile in spirit. When Great Britain was regarded as "the workshop of the world" and other nations had no alternative to buying British goods, it was a case of "Hobson's choice"; but now that half a dozen other countries have manufacturing pretensions and facilities at least equal, if not superior to those of England, it must be obvious to the most obtuse that unless the one-sided conditions now existing are modified, our operations will be closely invested by the enemy; Britain's position as a manufacturing nation will be no longer in the ascendant, and mass production, from an English point of view, will be robbed of its principal charm.

THE THEORETICAL AND TECHNICAL ASPECT.—This side of the question of mass production is of course a very important one—one which varies with circumstances, such as public requirements and tastes, the necessity for cheap workmanship combined with lightness and high efficiency, or—the reverse of that—the very highest possible class of workmanship in machinery of substantial proportions, where efficiency, as applied in the technical sense, is necessarily and purposely disregarded.

Here we approach a phase of the subject so vast in extent that I must be excused making more than a few remarks anent the fashionable or prevailing idea that technical education alone is going to "run the show" in future. The term technical education very often reminds me of the old saying—"The theory of music is one thing—playing the instrument another!" A learned professor may enlarge for an hour or two upon the art of driving a nail, or driving a golf ball; but the student, and perhaps the professor himself, might find the first few attempts at driving either the one or the other to be associated with some little surprise, if not with damage to person and property. It is the same in most things. The youth who "works" his skates for the first time or two, will learn more in five minutes about "contingencies" than he will by studying the theory of skating for a life-time.

Technical education without practice will not enable a man to jump right into the arena of industrial warfare and fight all comers—nor will it give him initiative, "grit," rough-and-ready common sense, determination and energy, or the peculiar faculty of making hard bargains and finding the best market for his goods. Neither will technical education alone give a man an eye for the beautiful, the graceful, or the practical. All those qualities are in-born to a large extent in the most successful men. Very often young children have pronounced tendencies and striking individualities and ideas long before they even have made the acquaintance of the A. B. C. of their education.

It must not be assumed from the foregoing that I am a heretic in the religion of technical education. I am nothing of the kind. I regard technical education, to a certain extent, as being the only door to success. When, however, it attempts to make a man *understand all things at all times,* it becomes a farce and a clog to progress and ruins the prospects of thousands of young men—men who have aimed too high for their real abilities or opportunities. Technical education, by which I mean technical education in one branch of trade or in one profession, is of vast importance to the youth who wishes to be, *not* a walking authority upon every conceivable subject, but thoroughly well versed in and fully equipped for the particular business or calling which he has chosen for his future career.

Take the man who wishes to become a leading gun maker. He must not only understand the theory of the gun, as well as of the explosive, but be a mechanic of the first water. If he wishes to make guns in large quantities, he must be fully acquainted with the most modern machine tools and be capable of taking full advantage of even the most minute improvements in the manufacturing processes. Greek, ancient history, and a perfect knowledge of all the classics would be of about as much value to such a man as a knowledge of dress-making. I had recently the opportunity and the gratification of being shown over a foreign gun factory, and I was assured that the cost of the labour and the material in connection with an extremely well-finished and handy little rook-shooting rifle was four shillings and two pence. The man who wishes to out-step the results in that establishment would have to begin very early in a morning, even if he carried a technical school about with him in his pocket.

Mass production has reduced the cost of labour in guns, bicycles, sewing machines, and many other similar goods, to a bed-rock condition of things, and nothing but an extensive experience in each branch of business, with a full and wide-awake knowledge of all the tips and

tricks of the trade—both technical and practical—will enable a man to keep abreast of the times, much less to wipe out his opponents.

There is no royal road to success in the matter of the organisation and the working of factories where mass production and standardisation are the dominating features. It may not be altogether a question of the best machine-tools, nor of the design of the article to be manufactured, but one, perhaps, of commencing operations by efficient "jigs," careful checking of operations as they proceed, and many other considerations which can only be acquired by experience and by coming into contact with the best men and the best appliances.

Some people believe in making themselves into professional men first, and engineers afterwards. They bang away at every conceivable technical subject till they are bald and then emerge into the world in search of employment. If they have a fond parent with a long pocket, and are favoured by opportunity and possessed of patience, energy, and gumption, they may ultimately succeed in life; but without those qualities and advantages they stand a poor chance indeed. Let me illustrate the meaning of all this by quoting a passage from a letter which I recently received from an old engineering friend in America. It is particularly pertinent to this subject, because we are here dealing with a matter which has called forth the best energies of the professorial element, in the endeavour to prove that the technical school is the only channel through which money—for that is what most people are striving for—is to be made.

"Hang any and every profession! The average counter-jumper makes a better living than a professional man—and indeed, in nine cases out of ten, the commercial man is more valuable both to himself and humanity at large than the professional man.

"The insight which I get in the working of the greatest corporations on earth confirms this view to me, and I fully believe that the men who plotted out the time-tables and organised the Pennsylvania Railroad System are *at least* as capable and valuable as the engineers, bridge-builders, and others who built the line. I am, of course, an interested observer and may be wrong in my conclusions, but I see it clearer every day that the best engineer is the one who does most with the least means, and that success and reputation follow concentration of energy, applied to one particular field 'which *can* be developed.'

"I engaged a man last week who is a thoroughly competent architect. He built villas abroad and can lay out a cathedral in a 'jiffy'—or a synagogue, which would deflect all the traffic if erected near any stock exchange—he has a wife and children, but no overcoat, and I

let him make tracings and am not quite sure whether he will maintain himself on this work even!"

How sad! But it is only the case of many draughtsmen over again. I have known quite a number of young fellows who have been thoroughly well educated; who were splendid draughtsmen and who had had a technical training of the "heavy" order—yet earned much less than fitters and turners in the shops, and had to keep up appearances. They were, however, short of commercial knowledge; knew nothing of handling men, nor of the great world of hard experience through which the successful mass-producer has to travel almost barefooted!

CONCLUSION.

It will be seen from this and previous articles that establishing new works for the profitable introduction of specialised machinery in order to arrive at maximum production is a matter of great complexity, involving questions of the highest importance, which must vary in accordance with the surroundings of each particular trade.

For me, therefore, or any other man, to attempt to lay down a set of hard-and-fast rules for the profitable introduction of specialised machinery for any and all classes of work would be impossible, and would be only imposing upon the credulity of my readers. In my treatise upon the "Commercial Organisation of Factories" I have dealt with system and organisation as the cardinal principles underlying successful shop management—whether it be a shop where articles are manufactured in large quantities or in small. System and organisation studied and practised with keen and enthusiastic intelligence, will bring out most of the good qualities essential to "Works Management for the Maximum of Production."

In concluding this series of articles I cannot do better than quote the words of a well-known American engineer—Mr. Tregoning.

"It has been said that 'system is the triumph of mind over matter,' and there is no doubt about the truth herein contained; we only get suspicious of the fact when taking a measured survey of the inner workings of some large factories, and gaze sorrowfully at the triumph of matter over mind.

"To work systematically is to work successfully. Method is the essential element on which every solid and substantial concern is based; and that factory, institution, or establishment of any kind which ignores it, conveys to the observer an impression that nothing permanent or abiding is intended, whilst on the other hand a systema-

tised manner of working stamps it at once with permanency—an establishment that means business and intends to carry it on for all time.

"I have heard it remarked that in business three things are necessary: knowledge, temper, and time; but I have seen all three prostrate and powerless for want of *method in the management.* Such is the evil of working in an unmethodical and slipshod manner, that it is not too much to say results have followed well-nigh ruinous to the concern.

"There is no doubt that the subject of factory organisation has been badly neglected in past years. That we have *not* advanced with the order of the times is the complaint I lodge against the doors of many managers. We are working on old systems which have served their day and generation—systems which 'have had their day' but, unfortunately have *not* 'ceased to be'; for a brief glance at many of them, both great and small, will prove that little or no method is used, and that the concern moves under conditions which are disgraceful; the wonder is how it moves at all. My observations have led me to conclude—and I say it after twenty years' experience—that the first and foremost want of many of our large factories is not *work,* but a thorough revision of the machinery that manages and directs the whole concern. It is not a want of brains, it is not the difficulty of working out a vast and complicated scheme, it is not a matter involving the company in a large outlay of money—it is simply a question of *method*—the application of a few simple rules, and a respect for the time-honoured principle that order is the first law of the universe, and the nearer our approach to it the more harmonious will our arrangements work.

"A perfect organisation I consider an essential and vital element in securing success, in whatever form of institution we may wish to carry on, whether political or religious, mechanical or social. I contend that it is not possible to found a lasting power upon a management in which systematic action is eliminated or ignored; a ramshackle condition of things is the ultimatum; and in many cases establishments have closed simply through a break-up from within of its *managing machinery.*"

THE EFFECTIVE LUBRICATION OF JOURNALS.

By F. W. Graham Snook.

MICHAEL ANGELO, on pointing out several alterations of detail in a statue, was met by the exclamation that they were but trifles. "Ah!" he replied, "trifles make perfection, and perfection is no trifle."

The remark is no less true of machinery; and of the many details of an engine none receives less systematic attention than the lubrication of bearings. This is all the more astonishing when it is considered how large a part the element of journal friction has played in the development of engine building.

The general application of the screw propeller to ship propulsion was long delayed by the difficulty of producing an engine to run at the speed of revolution necessary to the screw's efficiency. The introduction of the old geared engine is evidence of the trouble met with.

With the advent of the direct-coupled engine hot bearings became the bugbear of the engineer, and his thanks are mainly due to torpedo-boat engine builders for the now universal recognition of the fact that not only must a bearing be strong enough to withstand the stresses put upon it, but ample surface must be provided to prevent the viscosity of the oil being overcome and the unguent squeezed out.

It does not follow, however, that because a journal runs without heating its friction cannot be reduced, and it is the privilege of the quick-revolution dynamo-engine makers to have enforced the lesson that the method of introduction of the lubricant to the bearing is at least as important a consideration as the giving of sufficient area to the rubbing surfaces.

The torpedo-boat engine builder produced a smooth-running, quick-revolution engine; the dynamo-engine builder has demonstrated the gain in mechanical efficiency to be attained by means of an automatic system of lubrication scientifically applied.

If engine builders would but roughly estimate the waste of time and amount of trouble caused by hot bearings in engines before they have completed their trials, and if owners would take the trouble to find out the gain in mechanical efficiency and in diminished wear-and-tear from the adoption of an efficient system of lubrication, both would grasp the money value of attention to this detail of manufacture.

The use of the matter relating to Mr. Beauchamp Tower's experiments is by courtesy of the Council of the Institute of Mechanical Engineers.

Much attention has been given to the reduction of steam consumption per indicated horse power, but the relation of indicated horse power to brake horse power, or to horse power of useful work done, has received comparatively little attention.

When it is considered that in an ordinary engine working at full power, about 8 per cent., and at one-quarter power, about 35 per cent. of the power developed is wasted in journal friction, it will be seen that there is much room for progress in the direction of the reduction of this loss by more careful attention to oiling arrangements.

The extent to which journal friction depends on the manner in which the lubricant is fed to the bearing was most clearly demonstrated in 1883 and 1885 by Mr. Beauchamp Tower's experiments on behalf of the Research Committee of the Institution of Mechanical Engineers, and recorded in their Proceedings of those and subsequent years. An apology would be necessary for referring to information so old, especially in view of the comment it raised at the time of publication, were it not that engineers persist, with a strange conservatism, in their preference for a system which attempts the introduction of the lubricant to bearings at the worst possible point—that of the greatest pressure, or the crown of the bearing.

Referring to Fig. 1 it will be seen that in the experiments referred to a journal was used of 4 inches diameter and 6 inches long, with a top brass only which could be loaded as desired.

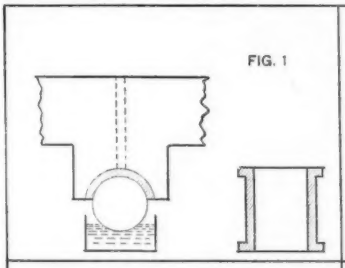
The journal was first lubricated by being run in an oil bath, the bottom of the journal just touching the oil. Fig. 1. (The oil hole shown by dotted lines has no connection with this experiment. The brass was plain, with no groove or hole).

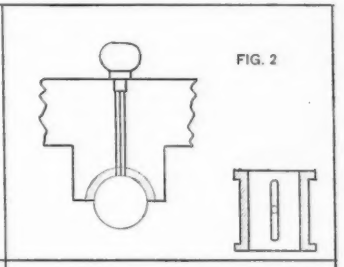
Then the oil was fed in through a hole in the top of the brass, after the usual manner, by a syphon lubricator. The form of brass was that of Fig. 2, and the lubricator that of Fig. 3. Finally, the oil was supplied from a pad on the underside of the journal which received its oil by capillary attraction only, the conditions being, except for the oil bath, those of Fig. 1.

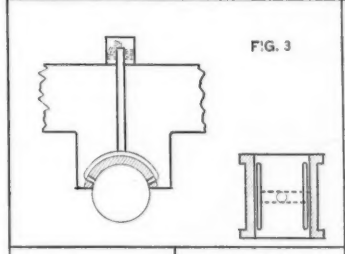
By reference to the table it is seen that if the friction with the oil bath method be taken as 1, that developed when using the syphon method was 7.06 and with the oily pad it was 6.48. The load was practically constant.

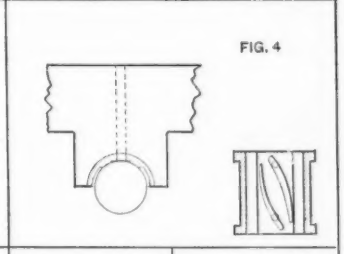
With the bath lubrication the shaft was, of course, wet with oil; with the pad the oil was just perceptible to the touch, and it could not be felt at all when fed by the syphon. Thus we see the lubrication can be so diminished as to make friction seven times greater with one

method of supply than with another, and yet the bearing will run without seizing. Hence the method of lubricating journals is of such importance that it may be well to recapitulate some of Mr. Beauchamp Tower's further experiments, to show that the usual method obtaining to-day is by no means the most efficient.









	ACTUAL LOAD IN LBS. PER □"	CO-EFFICIENT OF FRICTION	COMPARATIVE FRICTION
OIL BATH	263	.00139	1
SYPHON LUBRICATOR	252	.00980	7.06
PAD UNDER JOURNAL	272	.00900	6.48

PLATE I.

In the course of the oil-bath experiment already mentioned, a hole was drilled in the top of the brass to take an ordinary lubricator (see dotted line in Fig. 1), when it was found that the oil, picked up by the journal from the bath underneath, filled the hole and overflowed. A wooden plug was driven in only to be forced out by the oil. A pressure-gauge screwed into the hole recorded a pressure of more than 200 pounds per square inch, clearly proving that the brass was floating on a film of oil subject to the pressure of the load, and there was consequently no metallic contact between the bearing surfaces. The oil-bath method was found most efficient, as the bearing could be loaded to 625 pounds per square inch before seizing.

The next method tried was with a common needle lubricator, and grooves were cut in the direction of the length of the brass from a centre hole, as shown in Fig. 2. With a head of 7 inches, the oil refused to enter the bearing, which would not run cool with so small a load as 100 pounds per square inch. The oil hole was then filled up to the top with oil and the weight eased off for a moment. This allowed the oil in the hole to sink and lubricate the journal, but almost immediately the load was again allowed to press on the shaft, the oil escaping by the path of least resistance, or least pressure—the oil hole—rose in it to the former level and the journal became dry. Thus it is clear that, instead of being a means of lubricating the journal, this very usual groove-and-hole method was a most effectual one for removing all oil from it.

The centre of the brass being obviously the wrong place to introduce oil, holes and grooves were made as in Fig. 3. The oiling by this method was apparently satisfactory at light loads, but the bearing nevertheless seized with an actual load of 380 pounds per square inch. The grooves were then cut after the manner of locomotive axle boxes, and the oil introduced through two holes and grooves as in Fig. 4. The chord of the arc of contact was reduced from 3.9 inches to 2.25 inches. The lubrication was again so imperfect that with a head of 9 inches the underside of the shaft was quite dry, and the journal would only run with a load of from 175 to 200 pounds per square inch.

This is rather an extraordinary result, as car-axles are found in practice to have a coefficient of friction as low as 0.01, but this is probably due to vibration and end-play allowing a free flow of lubricant. The effect here is similar to that obtained by frequently striking from below a table over which a weight is being dragged, and has been called "dithering" friction.

The next experiment was a step back in the direction of the oil bath of Fig. 1. The journal was supplied with oil from a pad touching the underside, the bath having been removed. Though the oiliness of the journal was scarcely to be felt, it was evenly distributed and the bearing ran with from 551 to 582 pounds load per square inch, but seized with this after a few minutes' running. These experiments then show conclusively the futility of attempting to introduce the lubricant on the pressure side of the bearing.

Arrived here, the next question is palpably: "How is the pressure distributed on the pressure side of a bearing that we may know where to introduce the lubricant to the journal?" This is best answered by reference to a subsequent experiment of Mr. Tower. Having al-

ready found that the oil pressure in a bearing could be recorded by a pressure gauge, three ¼-inch holes were drilled lengthwise in the body of the brass and through a little more than half its length, as is shown by Plate 2. One hole is in the centre and the other two are on each side of it (Fig. 2). These holes, coming out at one end of the brass, were connected by converging copper pipes to a Bourdon pressure gauge. In order to ascertain the pressure at any point between the brass and journal, a hole of 1-16 inch diameter was drilled from the bearing surface of the brass into one of these longitudinal holes, thus making connection between that point and the pressure gauge. The pressure having been ascertained, the hole was stopped up and another drilled, and so on. The arrangement of the holes, which were successively tested, was as follows: The brass was supposed to be divided by six vertical planes—three parallel to the axis of the journal and three at right angles to it. The test holes were situated at the nine points of intersection of these planes. Of the three planes parallel to the axis of the journal, the one on the side where the surface of the journal enters the brass is called the "on" plane, the direction of rotation of the journal being indicated by the arrow in Fig. 2. That which passes along the axis of the journal is the centre plane; the remaining one, on the side where the surface of the journal leaves the brass, is called the "off" plane.

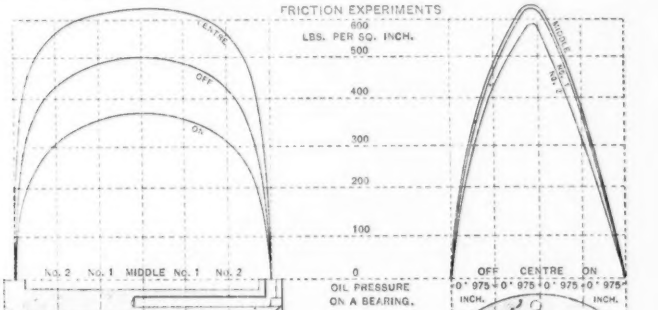


PLATE 2.

The pressure was thus actually read at nine places in the bearing, but as it is reasonable to suppose that the pressure must be symmetrically disposed on each side of the middle transverse plane, the pressures were observed on one side only of that plane and those on

the other side assumed to be the same, so that in reality the pressure may be considered to have been ascertained in fifteen different places distributed over the whole bearing surface of the brass. By the curves it is seen that the pressures per square inch are as follows:

Longitudinal Planes.	On pounds.	Centre pounds.	Off pounds.
Transverse Plane, Middle	370	625	500
Transverse Plane, No. 1	355	615	485
Transverse Plane, No. 2	310	565	430

The greatest pressure is seen to be on the "off" side of the centre, the pressure at the holes of the "on" side being in every case considerably less than at the corresponding ones on the "off" side. The line of greatest pressure, while very slightly to the "off" side of the centre, is almost exactly where the oil hole is made in the ordinary bearings of engine.

Let us now return to the experiments on the different methods of oil supply and examine the result by the aid of this last experiment. Taking first the gravitation method, with the grooves in the brass, Fig. 2, page 223, it was found impossible to run the journal when loaded to only 100 pounds per square inch. In the light of the last experiment, it is evident that as oil hole and groove are along the line of greatest pressure in the brass, the oil could not possibly force its way in. With the arrangement of holes and grooves as in Fig. 3, the result was better, as the bearing could be loaded to 380 pounds per square inch before seizing. This again stands to reason, as the oil holes and grooves are nearer the line of least pressure—namely, the edge of the brass. Coming now to the experiment with the oil pad touching the underside of the journal, it was seen that, with such a meagre supply as was scarcely perceptible to the touch, the journal could be loaded to 551 or even 582 pounds per square inch before seizing. This result was evidently obtained by actually getting the whole of the oil, small as the quantity was, into the bearing at the line of no pressure, or the edge of the brass, and having it thence carried round.

Finally, the experiment with the oil bath (page 223) is now mainly interesting as showing the effect, not only of the introduction of the oil at the right place, but of a more ample supply, on the reduction of friction and on the increasing of the load, the journal running in this instance with a load of 625 pounds per square inch before seizing.

It may be remarked that we have here been dealing with a bearing under constant thrust, a condition only found in single-acting engines, in car-axles, etc. In them is usually adopted a system of lubrication of the oil-bath type. This, however, is impossible in double-acting

engines, with top and bottom brasses, and in these is usually found the gravitation method of Fig. 2, page 223. Better results are obtained in practice than were got in these experiments, exactly because we are not dealing with constant-thrust engines, and no bearing is so tight as to prevent the journals easing away from the top brass, on the down stroke in the case of the main bearings and on the upstroke in that of the other bearings. Thus a certain amount of oil finds its way on to the journal, and is carried round with it.

In the case of car-axle and similar journals the "dither," or vibration and end play, serve the purpose of the alternating thrust in a double-acting engine, as was proved by Professor John Goodman, who found that when a load of 1,000 pounds per square foot was suddenly brought upon a bearing it took from two to three seconds before the oil was quite squeezed out and the full friction came upon the journal. While, then, the conditions observed in these experiments are not absolutely those obtaining in practice, it is at least evident that for the efficient lubrication of a journal these conditions must be observed:

First:—The oil must be fed into the brass at the point of least pressure, which is clearly at the side of the brass.

Second:—The lubrication must be ample and continuous.

Third:—As a corollary of this second condition, the oil supply must be automatic.

How, then, are these conditions fulfilled in practice?

The common mode of lubrication, or the "gravitation method," which seeks to introduce the oil by allowing it to gravitate through a pipe from a box slightly above, or even on the top of, the bearing itself, is in its application most open to criticism. The oil duct is almost invariably led to the centre of the top brass, or to the point of greatest pressure in the bearing, serving as an escape for the oil on the pressure stroke, as may be seen by the bubbling back of the oil into the oil hole, so often noticed. Hence, of necessity, we get a restricted supply of oil—and, indeed, were it not for the alternation of the thrust, which eases the pressure from the oil hole during half the revolution, no oil would enter the brass at all. That the alternation of thrust is not in itself sufficient to allow a bearing to be efficiently lubricated is shown by the fact that experience has led engineers invariably to cut grooves from the oil hole towards the sides of the brass—that is, towards the lines of least pressure.

Plate 3 illustrates an arrangement of oil grooves proposed by Mr. John Dewrance. Here the lubricant is led into the bearing at the points of least pressure—namely, the sides—and there is no escape provided

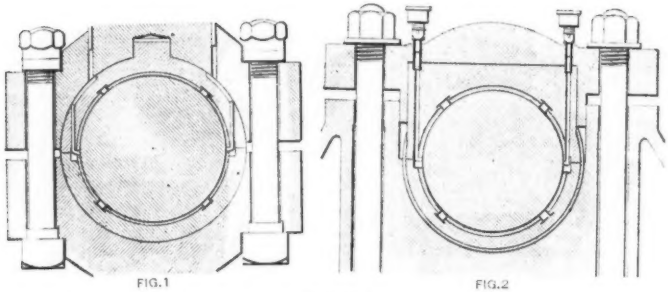


FIG.1 FIG.2

PLATE 3.

such as an oil hole and groove, at the point of greatest pressure—the crown of the bearing. It is, however, clearly of no avail to introduce an efficient type of oil hole and groove unless means are supplied to keep them fed with an ample and constant quantity of lubricant. For this purpose the ordinary wick syphon lubricator is almost universally fitted, but it is erratic, requires great attention, and leads to a considerable waste of oil, because, not being readily adjustable, a small bearing will often get as much oil as a large one, and the large one at times not enough, necessitating the use of the most wasteful of all lubricators—the oil can.

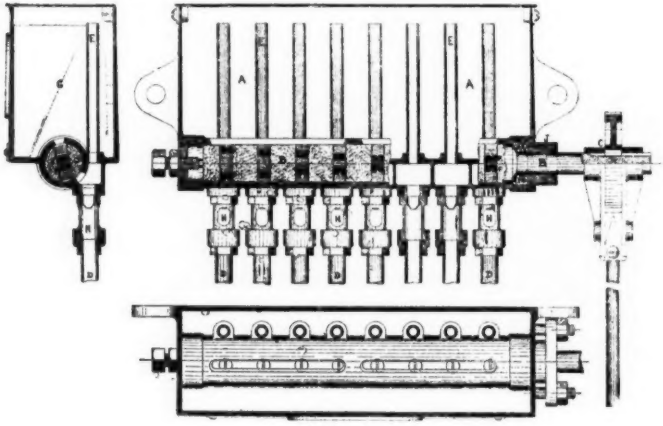


PLATE 4.

Any lubricator which permits fluctuations of oil supply cannot be regarded as good, for it either supplies too much oil when working freely, and thus is wasteful, or, on the other hand, too little, which

causes, if not heating, at least an increase of friction with consequent rapid wearing of the bearings and need for repairs.

Plate 4 shows an automatic mechanical lubricator which delivers a constant quantity of oil to each bearing, which supply can be regulated by means of the plugs in the spindle and by the moveable eye on the ratchet lever, so that each bearing, whether large or small, receives no more and no less than enough oil. With this apparatus, journal friction has in many cases been so reduced as to cause a very marked improvement in the life of the bearings, and in spite of this result, an invariable saving of 25 to 50 per cent. of oil.

The following synopsis of a report of a 90-days' trial on board ship, under ordinary working conditions at sea, fully bearing out the statement that automatic lubrication is essential to highest efficiency and economy, is worthy of the attention of all engineers and owners of steam plant:

Duration of trial	90 days.
Actual steaming time	80 days.
Type of engine	Triple expansion.
Type of lubricator	"Octopus" automatic.
Bearings supplied by lubricator	Top and bottom ends of connecting rods and guides.
Saving of oil	20 per cent.
Wear and tear before using automatic lubricator	Liners were removed at every port and usually after 23 days' steaming.
Wear and tear after fitting automatic lubricator	Bearings required no adjustment after 80 days' running when ship again left port.

Two other highly efficient modes of lubrication are the splash and pressure, which, however, only lend themselves to enclosed engines. Indeed, splash lubrication is only applicable to single-acting, quick-revolution, constant-thrust engines, which have no top brasses to the crank-shaft bearings and crossheads, and no bottom working brasses to the crank pins and eccentric straps.

The lubricant, consisting of a mixture of oil and water, is put into the crank chamber, which is filled to within ¾-inch of the underside of the crank shaft. The crank pins and bottom-end brasses, the eccentrics and straps, dip into the oil at each revolution and are flooded. The main bearings, crossheads, and guides are lubricated by the oil splashed up by the cranks at each revolution. In the case of the crank-pin bearings and eccentrics, which dip into the lubricant, we

have an almost exact reproduction of the very efficient oil-bath method. The departure in the case of the main bearings, crossheads, and guides would at first sight appear greater, but considering the high speed of revolution, there must be a practically continuous oil shower going on inside the casing. Therefore the difference between the oil-bath and splash method is, in this case, mainly one of name, and a high brake-efficiency in these engines is, indeed, the rule.

Forced lubrication, which is rapidly growing in favour for high-speed dynamo engines, is exemplified in the well-known Belliss engine. The crankpit forms a reservoir for the oil, which is forced, by a valveless, partially-submerged pump driven from the eccentric strap, into a main oil pipe at the back of the casing, from which branches lead directly to each main bearing. Holes drilled in the crank shaft take a supply of oil from the main bearings and conduct it to the crank-pin bearings; thence it is delivered by pipes through the interior of the crosshead pins to their brasses and to the guides. It then drains back and passes through a strainer before being again pumped into the bearings.

The pressure at which the oil is passed round the engine is from 10 to 20 pounds per square inch. While this is, of course, much less than that due to the load on the pins, it nevertheless insures the complete flooding of the brasses with a thick film of oil, as the pressure eases off the pins on the return stroke. Consequently the introduction of the lubricant at the sides of the brasses, while probably better even here—especially for crosshead pins, which do not revolve—is not so essential as with the gravitation and splash methods. Forced lubrication by this method is most efficient. Reference to the diagrams, Plate 5, bears this out in a remarkable manner.

On the diagrams are plotted the results of an official test of a Belliss self-lubricating engine. By way of comparison are shown by dotted lines the results of a trial of a single-acting splash-lubrication engine, which are useful as proving the relative merits of the different systems of oil supply. Referring to the left-hand diagram, which gives the relation of indicated horse power to the brake horse power, it is seen that in the Belliss engine with 217.8 indicated horse power the brake horse power is 209.5, giving a mechanical efficiency of no less than 96.3 per cent. At 50 indicated horse power or 45 brake horse power the efficiency is still 90 per cent. Thus, at a fourth of full power, there is maintained an efficiency as much as 40 per cent. higher than in most ordinary engines at this power. The single-acting engine shows an efficiency below 90 per cent. at full power, which falls more

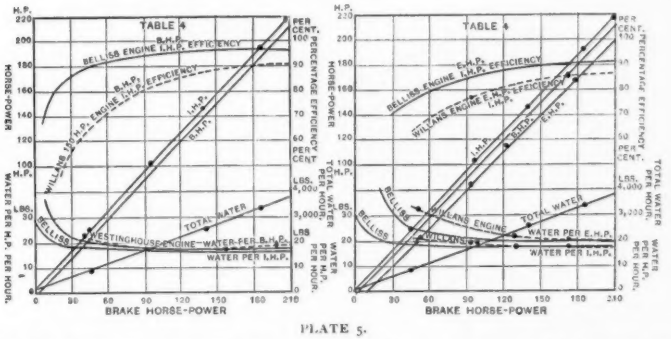


PLATE 5.

rapidly throughout, until at 45 brake horse power, which, for this engine, is more than one-third of full power, it is only 65 per cent.

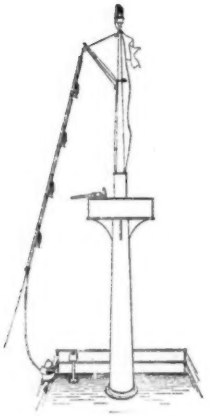
Coming now to the right hand diagram of Plate 5 the water used per indicated horse power by the splash-lubrication engine is actually less at full power than that used by the other engine, and it maintains its advantage well along the line. Turning to the water used per electrical horse power, or per horse power of output, considerable advantage is found throughout in favour of the forced-lubrication engine. It is, then, evident that the loss of economy is due to the greater friction with splash lubrication, the dynamo efficiencies being equal.

It is unfortunately usual to speak of water or steam consumption as so many pounds per indicated horse power, and the relative merits of engines are often fixed on that basis; but in doing so no account is taken of the difference of friction, which, as is shown above, may be so considerable as to render an engine, which is more economical than another in water per indicated horse power, less economical per brake horse power or per horse power of work done.

This mode of computation of an engine's efficiency and the difficulty of getting the brake horse power on marine engines, is the greatest obstacle in the path of the adaption of better systems of lubrication in the ordinary engine. Speaking generally, it is evident that the gravitation method is at present the least economical, by reason of the defective mode of fitting and the almost universal omission of an automatic oil supply. When 96.3 per cent. brake horse power efficiency, or only 3.7 per cent. less than possible mechanical efficiency, has been attained by means of a good system of oiling, it is surely unnecessary to point out to engineers and steam users the money value, not only of the increased output per pound of steam at all powers, but of the great saving in repairs.

ELECTRICAL APPARATUS IN MILITARY OPERATIONS.

By John P. Wisser.



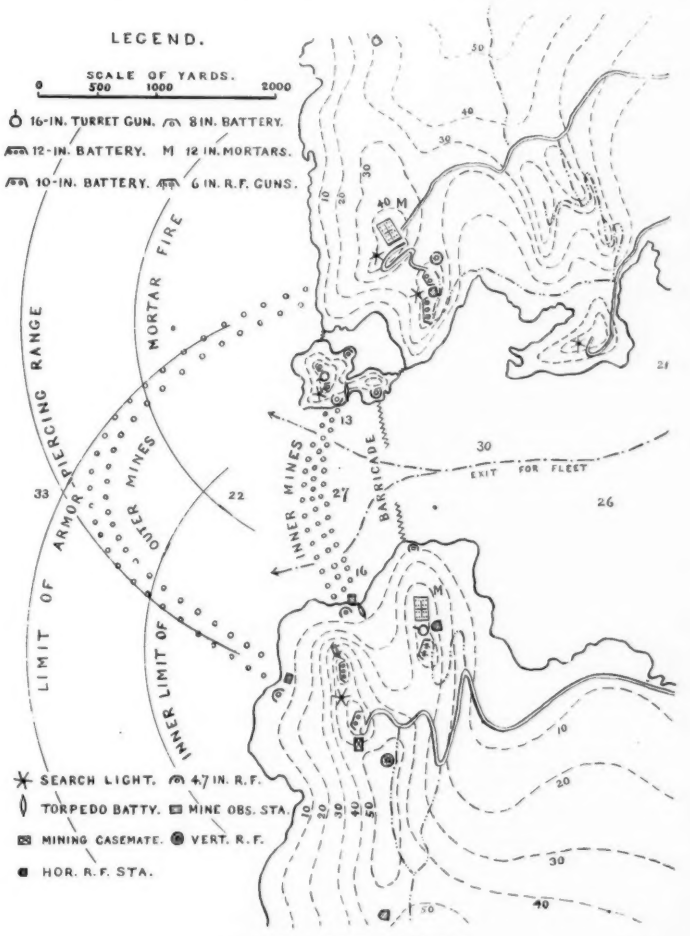
Military Mast with Ardois Lights.

THE military and naval applications of electricity have been presented and discussed from time to time for the past ten years or more, but the use made of electrical apparatus in the Transvaal war has added a new interest to the subject, and the establishment of a school for electrician sergeants in the United States army, the first of its kind, has suggested how indispensable is the electrical engineer in modern warfare. Moreover, the war with Spain gave a great impulse to the development of electrical plants in the new American coast fortifications, and the solution, by means of electrical apparatus, of ballistic problems relating to the fire of coast artillery added much valuable information for increasing the accuracy and rapidity of artillery fire, so that this appears to be an appropriate time at which to review what has been accomplished, and to indicate the lines along which electrical engineers should carry on their investigations for military applications.

The subject naturally falls under three great heads, namely, the apparatus required at permanent fortifications, that used in the field, and that needed to carry on investigations in the artillery arsenals and laboratories.

Electricity enters into all the elements of a modern fortification, for connecting the separate forts and batteries, for firing the guns, for lighting the magazines, for the signal apparatus, and for the search lights, communications, torpedoes, and range-finders. Indeed, no other branch of science has done so much to improve systems of defence, and without it our present system would not be possible. Moreover, among electrical apparatus, nothing has been so effective in economizing men and material as the storage battery.

A modern fortified harbor comprises a series of separate fortifications, often separated by water; and, since the present system of coast



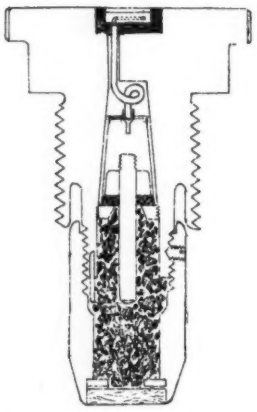
A MODERN FORTIFIED HARBOR.

defence places these (for most efficient action) under one command, it is essential that these isolated forts be in intimate communication with one another by means of cables and telephones or telegraphs, and be connected also by telegraph and telephone with range-finders in stations at the ends of a horizontal base line on the shore, and with vertical-base range-finders located at convenient points; there are also submarine mines or torpedoes in the ship channel, connected by

cable with a mining casemate, search-lights to light up the channel or the torpedo-field, signal lights run by storage batteries, for signaling to friendly vessels in the harbor or to the patrol boats outside the entrance, and a complete electric plant, with engine, dynamo, storage battery, and switch-board for lighting the magazines and furnishing current for the electric firing of a group of guns or mortars.

Firing guns by electricity is largely confined to mortars and rapid-fire guns. The modern rifled mortars are arranged in groups of sixteen, in pits, behind parapets, and are aimed not individually, but all parallel to one another and with the same elevation, so that when fired in groups of eight or sixteen the projectiles fall over an area about equal to that covered by a large ship. This firing is generally accomplished by means of an electric current from a storage battery, each piece being fitted with an electric primer for firing the charge.

Rapid-fire guns (4.7 inch or 6 inch caliber) are provided with electrical firing gear, connected with an electrical pistol, fixed to the carriage, so that a man laying the gun can fire while looking over the sights by merely pulling the trigger of the pistol.

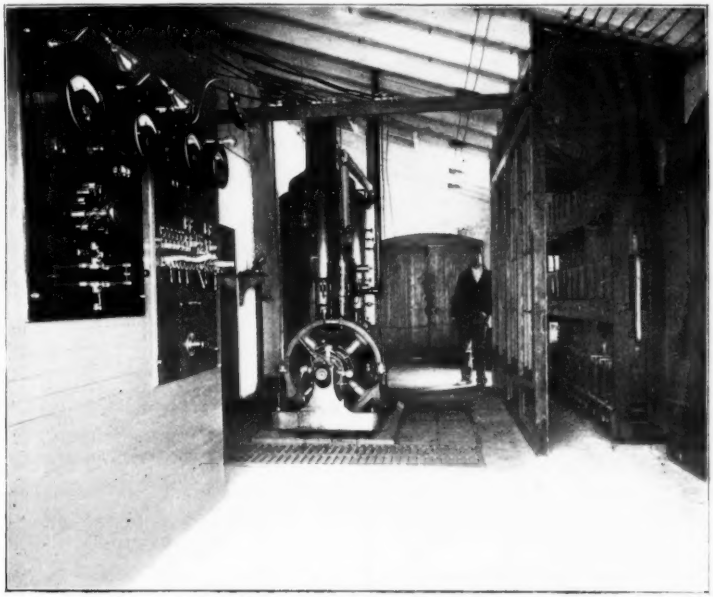


FUSE FOR 4.7 RAPID-FIRE GUN.

The current for firing is derived from a three-cell electrical battery placed on the carriage, one terminal connected to the pistol and the other to the carriage as an earth connection. There is also an alternative firing gear, which is used in case the first fails; it consists of a long cable, with a split pin at one end, which is pushed into a hole in the head of the firing needle, the other end being connected with the battery. In this case firing is accomplished by pushing down the end of a firing key at the middle of the cable. The great advantage of this method of firing is that the gun can be kept constantly on the target (moving ship or boat) and fired at the proper instant.

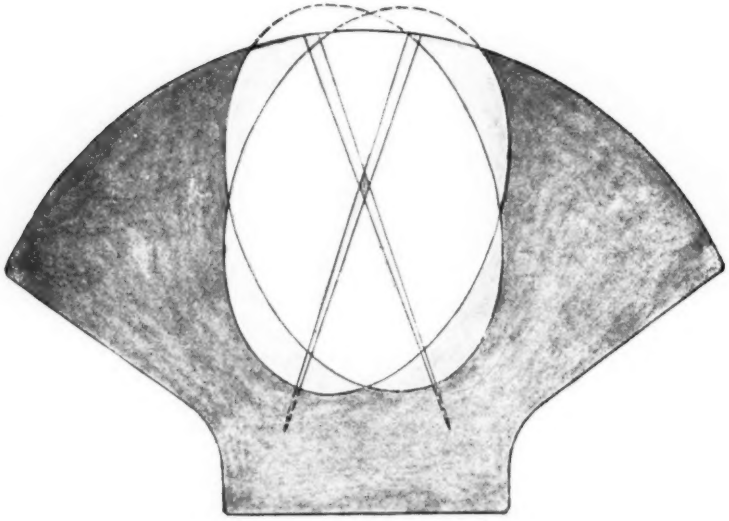
Night firing is accomplished with these guns by means of electric night sights, an arrangement for lighting up the sights of the gun by means of small electric lamps fitted with lenses, the current of three Leclanché cells being sufficient. By means of an adjustable resistance the light can be modified to suit any degree of darkness.

Range finders, to give to each battery of guns the data necessary for determining its distance to the target (any hostile ship in the harbor), are essential for guns fired, as the mortars are, without direct aim on the target, and for guns on disappearing carriages. In the United States' service, the only one involving the application of electricity in its operation is the Squier-Crehore horizontal-base



INTERIOR OF ELECTRICAL-PLANT ROOM OF A MODERN COAST BATTERY.
Engine, dynamo, storage battery, and switchboard.

range finder. Its two instruments are located in the stations at the ends of the base line, one being merely for observing, the other for both observing and plotting. The latter has two instruments, one for the plotting station proper, the other to be set parallel to the instrument at the other station. This parallelism was effected by means of an alternating current, using the principle of the Wheatstone bridge, parallelism being indicated by zero reading of a galvanometer in the circuit. This parallelism can, however, also be effected by giving the second instrument the reading of the one at the far station, sent in by telephone, without regard to the galvanometer. When the two instruments at the plotting station are properly set for the position of any hostile vessel in the harbor, the light from an



SQUIER-CREHORE RANGE FINDER. SHADOW LINES.

incandescent lamp or acetylene burner in each is reflected upon the plotting table (practically a chart of the channel) forming two shadow bands (one from each instrument), which are the magnified images of a steel band in front of each condensing lens of the lamps. Their intersection marks the position of the vessel on the chart.

This range-finder is at present the most accurate and reliable in the United States' service. The application of the alternating current was temporarily given up by the inventors, as it was but hastily tested at the outbreak of the war with Spain, and the instrument had to be put in active service at once; but even without that it is a valuable and convenient range finder, and one was in daily use during the late war for exercising the batteries at Fort Monroe, Va.

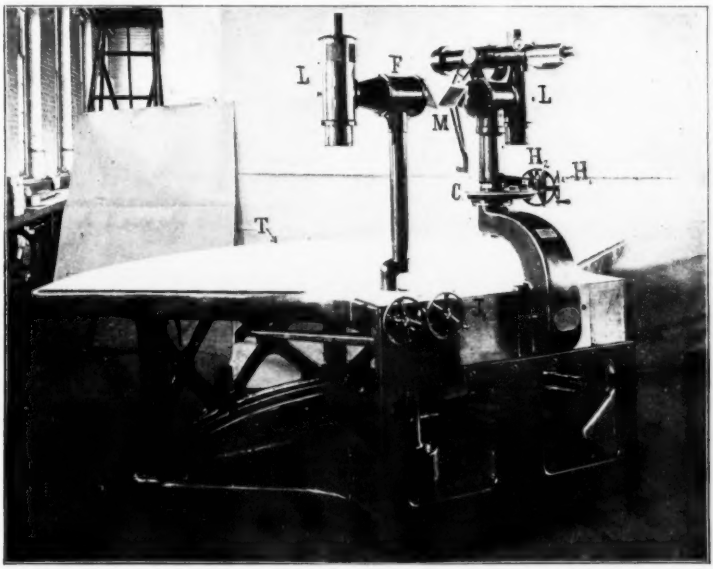
Torpedoes come into play in coast defence in two quite distinct ways—as mobile torpedoes, fired through torpedo tubes, like those of the navy, and fixed torpedoes or submarine mines.

Mobile torpedoes are launched from shore batteries placed at points where the ship channel comes in close enough for their effective action, and their purpose is the destruction of the enemy's vessels. Many of these torpedoes involve the application of electricity, either in having their motion controlled by a current from the shore, like

the dirigible torpedoes (Sims-Edison, Victoria, and Brennan), or a motor on shore is used to start the mechanism of the torpedo, and the shore connection is broken in the launching of the torpedo, as in the automobile torpedoes (Howell).

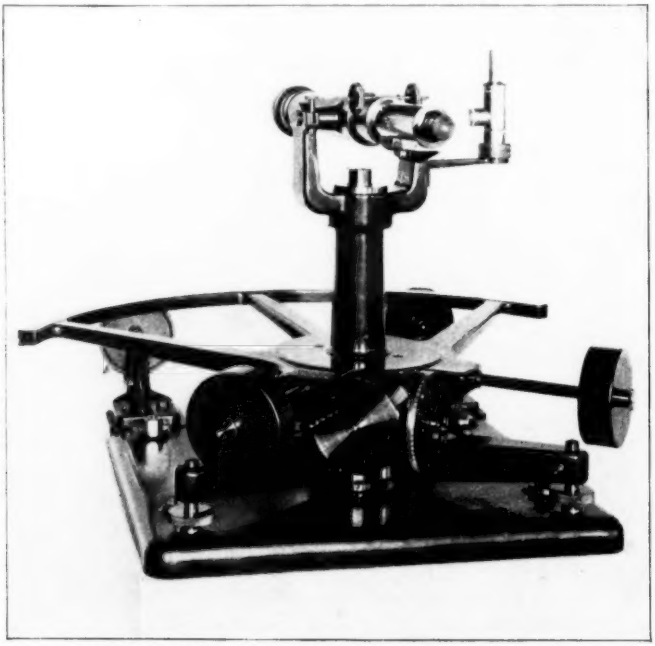
Submarine mines are used to obstruct the passage of vessels past the batteries. They are of two kinds, both electrical, viz., contact mines, exploded automatically, the electrical circuit through them being completed when a vessel comes in contact with them, and judgment mines, fired by pressing a key in the mining casemate on shore. The latter is located in some protected spot, and from it cables run out to the torpedo field. It contains storage batteries to furnish the current and a key-board for making contact in firing the judgment mines. It also has a chart of the channel, on which is indicated the position of every torpedo. For judgment firing two observing stations are also needed, so that the moment a ship arrives over any particular torpedo may be determined, and the information transmitted to the mining casemate.

Judgment mines are also contact mines, in that the striking of a ship on them closes a circuit which indicates in the mining casemate the torpedo struck, and the latter can then be exploded by pressing



SQUIER-CREHORE RANGE FINDER. OBSERVING AND PLOTTING STATION.

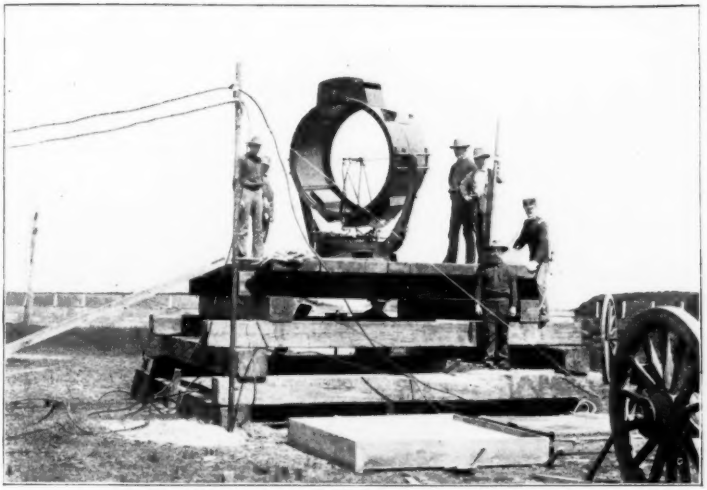
the proper key. Search-lights are used for lighting up the channel at night, and especially the torpedo field, since that is particularly subject to inroads at night. They are placed at high points on the coast, not only for the service of the different batteries, but also to light up portions of the channel for the safe passage of friendly ships at night. Search-lights consist essentially of an arc light in the focus of a concave mirror, the source of the current being usually a storage battery, although in some cases engines and dynamos are used. The mirror



SQUIER-CREHORE RANGE FINDER. OBSERVING STATION ONLY.

revolves on a horizontal axis for throwing the beam far and near, and on a vertical axis for throwing it to right or left. These motions may be given by hand, but are more advantageously imparted by means of a controller, which may be placed in a safe position under cover of a parapet.

The plates represent the large Schuchert search-light, with its engine, dynamo and controller, which had been on exhibition at the World's Fair in Chicago, but were installed during the Spanish-American war at Fort Monroe, Va.



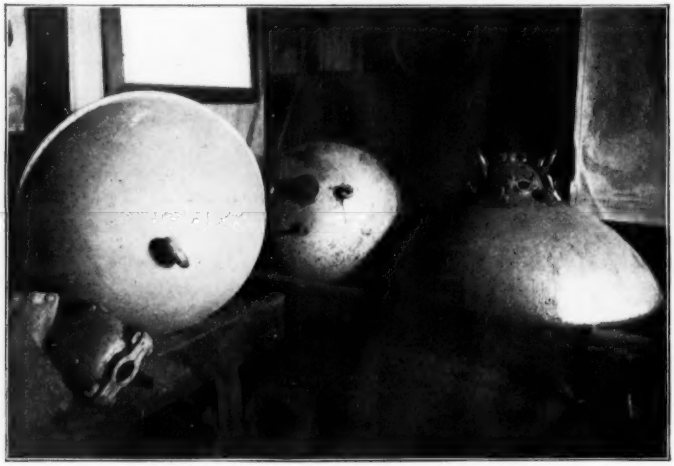
MILITARY SEARCH-LIGHT FOR FIELD USE.

The Ardois signal light consists of four pairs of incandescent lamps with colored globes (the upper red, the lower white) fastened to a cable, suspended from the peak of a pole or mast. An electric

DYNAMO, CONTROLLER, AND TRACTION ENGINE FOR MILITARY SEARCH-LIGHT.

current is supplied from a storage battery, and by means of a key-board, the keys of which are marked with the letters of the alphabet, these letters can be signaled by the lights, using the wig-wag signal alphabet, red corresponding to 1 and white to 2 in that code. Since it is in common use aboard naval vessels it is particularly convenient for communicating at night with friendly ships in the harbor, or with patrol boats patrolling the harbor.

The electric plant of a battery, or group of batteries situated close to one another, is usually contained in a separate building, and comprises an oil engine, a dynamo, a switch-board, and a storage battery. Its purpose is to furnish the light for illuminating the galleries, mag-



SUBMARINE MINES, TO BE FIRED ELECTRICALLY.

azines, and store-rooms of the emplacement, and, if necessary, to furnish the voltage for firing the guns by electricity. The great advantage of the storage battery for military use is its economy in men. One man can easily take care of the entire plant of a battery, and he is hard at work only one day in the week, when he is charging the storage battery; the rest of the time is at his disposal for keeping his apparatus in order, and for attending to the switch, when necessary.

Several complete systems of communication are required in every permanent fortification. The means now generally used is the telephone, but if that fail the telegraph can readily be substituted. In the first place, there must be such a system that the fort commander can go to some central station (as one of the range finder stations) and

METHOD OF SUSPENDING LANTERN.
(By courtesy of the General Electric Co.)

send orders to any other station or to any battery of the fort, without interfering with the regular transmission of the data from the range finders. This requires a separate line and a separate telephone in each station and battery, including search-light, signal light, etc. In the next place, each range-finder must have an independent line to the batteries which it is intended to furnish with data and information. Then there must be in addition a system connecting the observation stations for the torpedo service with the mining casemate. These lines are now generally underground cables, the overhead wires being too readily destroyed by the enemy's fire.

Electricity, therefore, pervades every nook and corner of a modern fortification, and at every turn electrical engineers are in requisition. This has been so keenly felt by the military authorities that electrician sergeants are now a part of the non-commissioned staff of every fort in the United States, and a school for the instruction of candidates for this grade has recently been established at Fort Monroe, Va., and already numbers some thirty students.

There are two great desiderata in the equipment of a fortification, toward which efforts at invention and improvement should be directed —a durable and reliable dry cell for use in firing rapid-fire guns electrically, and a quick system for converting the data obtained by the range finder and transmitting them to the gunner in the form of range from his piece.

THE ARDOIS KEYBOARD.
(By courtesy of the General Electric Co.)

IN THE FIELD.

The applications of electricity in the field are far more limited than in permanent fortifications, but in their effect on the operations they are of immense importance. Until quite recently the only application of any importance was the field telegraph or telephone, but to these must now be added wireless telegraphy, search-lights, and automobiles.

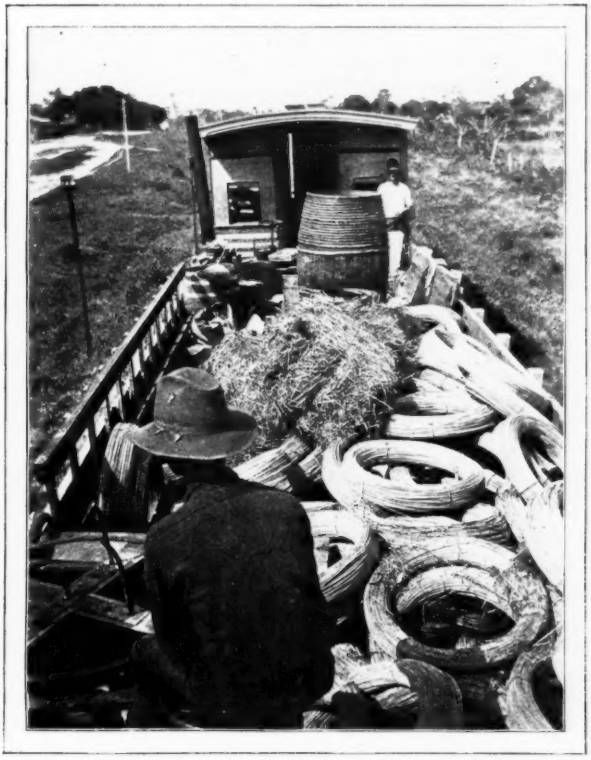
The development of the field telegraph is an interesting example of the use made by the science of war of progress in the other sciences; but aside from that it illustrates also the fact that it has a little realm of progress all its own, in which the requirements of the service demand new adaptations of principles long known.

The first material (following that used in civil life) consisted of bare copper wire on poles, but the train required to transport the material limited its application very much, and efforts were made to lighten it, especially as regards the poles. Then it was proposed to use insulated wire and lay it directly on the ground, but it was soon found that this was too liable to destruction by the troops on either side, and for a time this method was abandoned. Indeed, it required the experience of two wars (1870 and 1878) to convince the two nations, Germany and Russia, that in order to use bare wire on poles in the field it was necessary to educate the soldier by annual peace manœuvres to appreciate the necessity for keeping intact his own army's communications; he found the poles useful for fire-wood, and applied the wire to many useful purposes other than that for which it was intended. The insulated wire, however, was finally adopted, but in the form of a cable, the conducting wires of copper being strengthened by means of one or more strands of steel wire.

The English (1888) field cable has one steel wire and six copper wires; its diameter is 0.22 inch, its weight 169 pounds per mile, and the ratio of its tensile strength to its weight is 2.56; while the latest German (Siemens) cable has seventeen steel and three copper strands, with a diameter of only 0.13 inch, a weight of only 77 pounds per mile, and a ratio of tensile strength to weight of 7.37.

These improvements allowed of small, light wagons for transporting the material, and the latter could be unrolled directly from the wagons, so that the mobility and rapidity of laying were immensely increased and the telegraph could be carried to the front line of the main body of the army in the field.

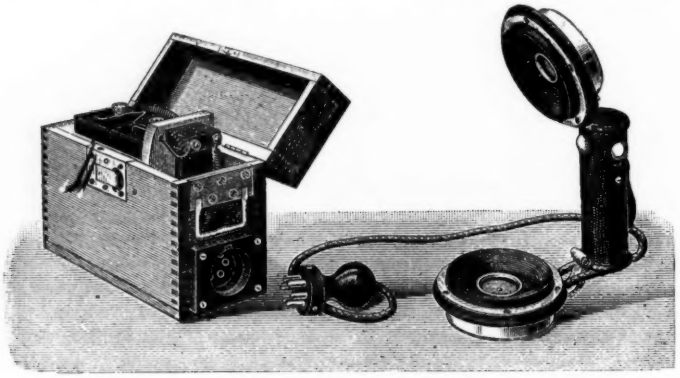
But efforts at improvement were continued with a view to carrying the telegraph into the outposts, and the first step in this direction



CONSTRUCTION OF A MILITARY TELEGRAPH.
Train erecting line from Puerto Principe to Nuevitas, Cuba.

was made by the introduction of the Buchholtz outpost cable, of the same diameter as the Siemens field telegraph, but lighter in weight. Its ratio of strength to weight (2.38) was, however, too low, so improvements were started in an entirely new direction, by giving up the cable altogether, in this zone of the field of operations, and using a bare wire laid on the ground with but slight ground connection, adding the Cardew sounder (first used in the Egyptian campaign of 1882), in which the extra currents of self-induction are used, a telephone acting as receiver. The Austrian cavalry patrol apparatus, ten years ago the best in use, was so light that it could easily be carried by a single trooper. The wire is very fine, the entire roll of 540 yards

weighing only a little more than half a pound. The later German apparatus (1897) is a further improvement, and in its present state meets all the demands for its full application in all positions on the field of battle, even to an outpost or patrol composed of a single soldier.



SIEMENS-HALSKE FIELD TELEPHONE EQUIPMENT.

The telegraph still has the great advantage over the telephone in its much greater certainty of action under the various conditions liable to arise in war. Nevertheless, the other advantages of the telephone are so forcible that it will certainly be used as long as it can be, and wherever it is possible to find employment for it practically. Hitherto, the bulk and weight of the necessary apparatus have interfered greatly with its field use, and this difficulty has been due mainly to the call bell. Moreover, the time that would be lost in taking out the telephones of a field line in case they failed, and putting in the telegraph, combined with its less certainty of action, have militated against its extended field use at the front.

Late improvements, however, have overcome some of these disadvantages by so combining in the same apparatus a telegraph instrument with a telephone that a mere turn of a switch will throw in or out one or the other, and by introducing a reliable call bell. The instrument now used in the German army is that of Siemens & Halske, the entire outfit for which is contained in a wooden battery chest and a leather telephone case, the whole weighing about nine pounds. The battery chest contains a battery of two dry cells, the switch and key, and an induction coil, with primary, secondary, and tertiary coils; the telephone case contains the telephone and the micro-

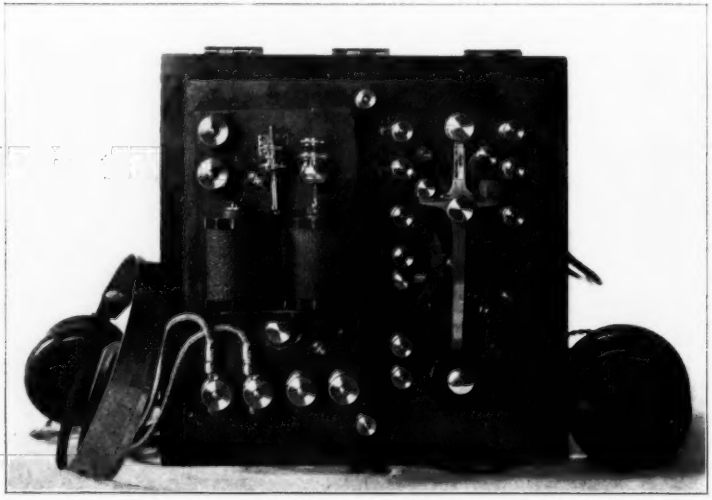
phone or buzzer. A turn of the switch and the depressing of the circuit closer puts the instrument in condition for calling or for telegraphing, the circuit, through the induction coil and microphone, being completed by a key. When the key is depressed the current from the battery, through the primary, causes rapidly alternating induced currents in the microphone, which are reproduced in the secondary, producing a buzzing in the telephone receiver at the corresponding station. By turning the switch in the opposite direction and leaving the key open the electro-magnet is cut out and the circuit is an ordinary telephone circuit with the microphone as receiver.

A similar apparatus is in use by the United States Army Signal Corps in the Philippines, the field outfit being contained in a box of about nine cubic inches volume. The wire used for telephone connections at the outposts is No. 22 copper, carried on a portable reel.

FIELD TELEGRAPH EQUIPMENT. A BICYCLE REEL.

This wire can be used naked, and has been so used over a line thirty miles long; but for safety, and in rear of the outposts, where rapidity of laying and portability are not such essential qualities, cables composed of a central wire of copper surrounded by six steel strands are employed, and the whole is insulated with pure rubber.

The telegraph and telephone work of the Signal Corps in the Philippines has exceeded any previous record of military telegraphy, and its enormous work may be illustrated by the fact that in the extensive field operations during last January an average of five thousand messages per day were sent.



TOP OF "TYPE B" U. S. FIELD TELEPHONE-TELEGRAPH APPARATUS.

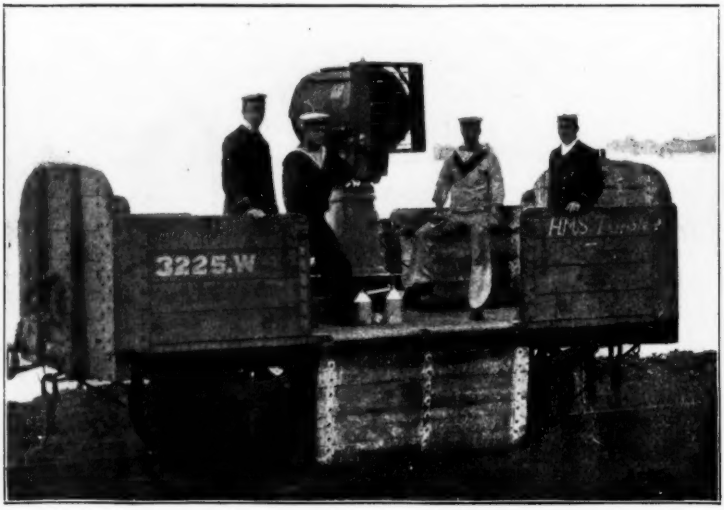
Before the war of 1870-71, optical telegraphy comprised signaling by means of flags by day, and by means of lanterns or torches by night: but in that war the heliograph proved its efficiency, especially in maintaining for a long time good communication between Mount Valerian and Versailles, so it was generally adopted. The electric light was at once suggested to make the system independent of sunshine and fair weather, but the difficulty of having it on hand in the field was then too great, so other sources of light (such as improved petroleum lamps), were used for a time, and the army telegraph trains of France, Austria, Italy, and Denmark were fitted out with apparatus of this kind. England, however, adhered to the heliograph.

MILITARY OUTPOST CABLE CONSTRUCTION.

The operator, kneeling on the ground, is telephoning to headquarters. The machine in front of him is for letting out and taking up insulated wire.

FIELD SIGNAL PARTY, WITH CABLE CART, FLAGS, HELIOGRAPHS, AND TELEPHONE KITS.

and had great success in its use in India and in South Africa, in some cases for distances of more than one hundred miles. Ordinarily, however, the heliograph, using as it does the sun's rays as the source of light, is limited to a range of about fifty-five miles; but by means of relay stations it can, of course, be used to much greater distances.

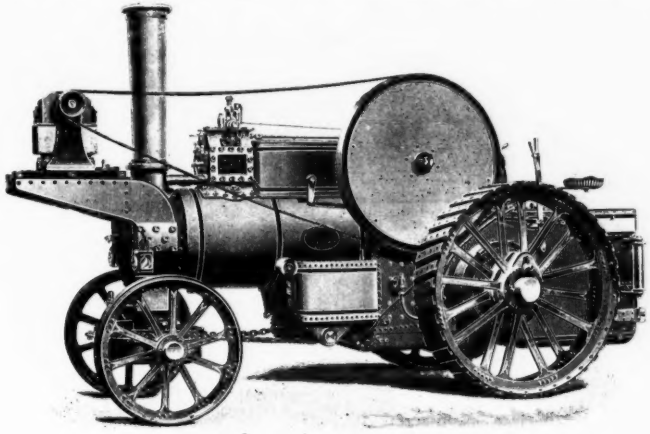


SEARCH-LIGHT ON RAILWAY TRUCK, TRANSVAAL WAR.

However, in the field such relay stations are liable to interruption by the enemy's cavalry, the messages can often be intercepted at certain points by interposing a cloud of smoke made by burning brush or damp straw, and, finally, the number of repetitions required not only delays the message but also increases the chances of error. The electric-arc light is far more efficient than the reflected rays of the sun, and is also independent of the weather and can be used by night as well as by day. By its means the range has been extended to more than four hundred miles. In the Transvaal war the British made use for this purpose of the electric search-lights from the ships, and this was, indeed, the only means of communication with the external world relied upon by the besieged garrisons of Ladysmith and Kimberley. The traction engines, which the British used so extensively in the Boer war, are also provided with search-lights, which are run by dynamos driven by the engines.

The Austrian field train is provided with a portable search-light transported on three wagons, its parabolic projector having a diameter of nearly three feet. Würtemburg has in its field train a single wagon for this purpose, containing a 5 horse-power petroleum motor and a dynamo furnishing a current of 65 volts 40 ampères, the entire wagon complete weighing only 4,500 pounds, and therefore being capable of going over any kind of road. The search-light wagons of Switzerland and Germany are somewhat heavier, and are intended for use in fortifications or along the coast.

The system of wireless telegraphy, as Professor Trowbridge of Harvard University tells us, "is emphatically a spark system strangely analogous to flash-light signaling, a system in which the human eye with its rods and cones in the retina acts as the coherer, and the nerve system, the local battery, making a signal or sensation in the brain. Indeed, there is a close parallelism between the search-light and the spark used in Marconi's experiments: both send out waves which differ only in length." The magnetic waves of the spark are more than a million times longer than the light waves, and are able to penetrate fog,



TRACTION ENGINE WITH MOTOR FOR ELECTRIC LIGHT.
Used in the Boer war

and even sand hills and masonry. Wireless telegraphy will probably find its most important application in the navy, but will also be useful between the isolated forts or stations of a harbor, when other communications are interrupted, and in communicating with beleaguered garrisons. Secret wireless telegraphy is not yet a solved problem. The

message spreads out from the sending spark in circular ripples in all directions, and may be received by anyone; it will be necessary first to invent a receiver which will properly respond to a definite number only of the impulses sent out.

Experiments are being conducted, however, in nearly all countries, to test its utility for military use, and during the past month the garrison of Antwerp, in Belgium, was assembled to witness the action of the apparatus between different parts of the fortifications.

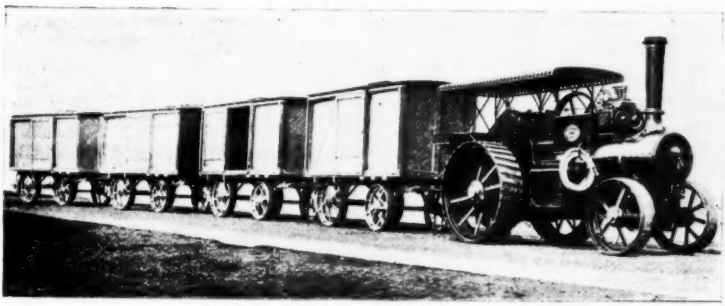
England sent to the Transvaal last December a section of telegraphers, supplied with a number of wireless-telegraphy stations, to prac-

NIGHT SIGNALING WITH ACETYLENE LIGHT.

tice this system in the field. It was used successfully to communicate with the besieged garrison of Ladysmith. Some of the stations (to obtain greater height of vertical wire) were established in balloons. Definite reports of the work are, however, not yet available.

The question of the application of motor wagons for purposes of transportation in the field army has attracted marked attention from all the principal nations, but the experiments in Germany and Italy have

U. S. SIGNAL CORPS AUTOMOBILE MILITARY WAGON.



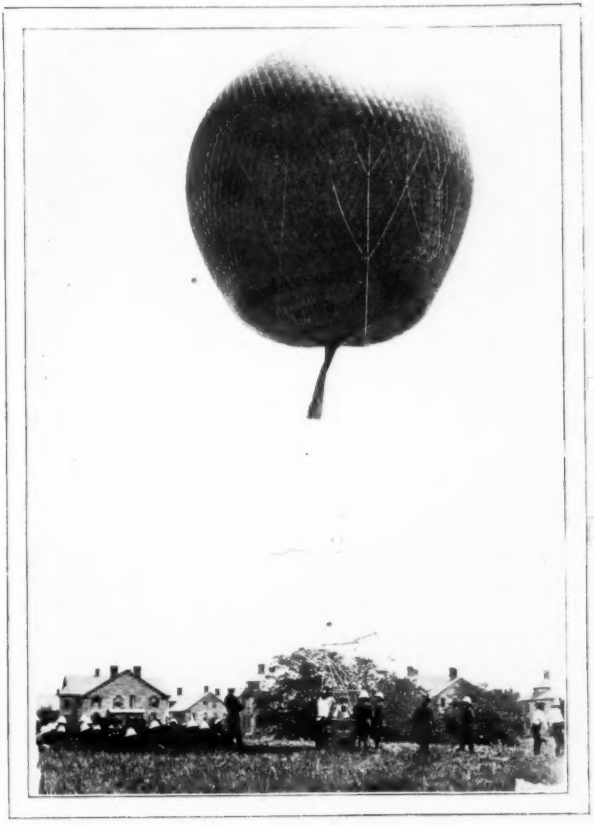
TRACTION ENGINE USED IN THE BOER WAR.

thus far been unfavorable to their selection for this purpose, the preference being given to traction engines. The two systems may be thus compared:

Ten automobile wagons of normal type, weighing 30 tons (12 of which are useful load), can cover daily a distance of 47 miles, the length of train column being 195 yards; whereas, a traction engine, with tender and two-wheeled wagons, weighing in all 30 tons (12 of which are useful load), can cover daily the same distance, the length of train column being only 110 yards. Moreover, in the first case there are ten pieces of apparatus to get out of order, in the second only one.

Nevertheless, automobile wagons have been introduced in several armies. England, for example, has two types—one an armored observation car, built for use in the operations in Egypt, to run on the railroad tracks there, capable of carrying a Maxim gun, two officers and one man; the other, for ordinary roads, also armored, and carrying two Maxim guns and a dynamo to supply a current for a search-light, which current can also be turned into the steel blinds (closing the doors and windows) in such a way so to give an electric shock to an enemy boarding the wagon. In both types the power is derived from a benzine motor with electric ignition. The Signal Corps of the United States Army has also adopted two electromobiles, one for transporting the officers, the other for carrying the men and materials. There are two 3½-horse-power motors (one under each rear wheel), run by storage batteries, one charge being sufficient for 30 miles when carrying 1,500 pounds' transportation load. The tires are solid hard rubber, and the maximum speed of the wagons is ten miles an hour. They are fitted with electric lights externally and internally, and a new form of search-light is to be added.

Balloons.—The application of electricity to balloons is, of course, secondary in character. The fixed (anchored) balloons (spherical or sausage-shaped) have no electrical appliances in themselves, although they may carry electrical instruments for telegraph, telephone, or wireless-telegraphy work. But some of the forms of dirigible balloons involve electricity either in their electric motors or in the electric ignition of their benzine motors. One of the latest forms involving the latter is the great balloon of Count Von Zeppelin, just completed at Stuttgart, Germany, which is to make its trial trip on the first favorable opportunity. It is 135 yards long, 13 yards in diameter, and its cubic contents are about 12,000 cubic yards, while its weight is about the load of an ordinary railway car. Its motive power is derived from two benzine motors (with electric ignition), located in the two boats under-



U. S. MILITARY BALLOON GENERAL MYER.

neath the main body of the balloon, which set in motion four symmetrically disposed screw propellers, 1 yard in diameter. The action of the screws was tried by placing them (above water) in a small launch, and it was found that the launch was moved through the water by these aerial screws at a rate of more than 8 knots, so that there can be no question as to their action on a balloon moving in air. The entire frame-work of the balloon is of aluminum and it is covered with pegamoid linen cloth.

Its conception and construction are regarded as the most important step in aeronautics since the discovery of the balloon, and its trial will

be watched with great interest, especially by the military world, which has long been striving to perfect a dirigible balloon.

All the great nations of the world have recognized the necessity for carrying on investigations in the subject of ballistics, in order intelligently to meet and solve the great problems of artillery constantly rising. These investigations are carried on at the artillery arsenals, many of which, like those of Woolwich, Vienna, Spandau, Cherbourg, and Toulon, have become famous. The United States laboratory at the Artillery School at Fort Monroe, Va., has done much to further the science of artillery, for there Captain Zalinsky began the experiments which led to his dynamite gun, there Captain Lorain made the first telescopic sight used by the United States artillery, and there Professor Crehore and Lieutenant Squier constructed their chronograph and their range finder.

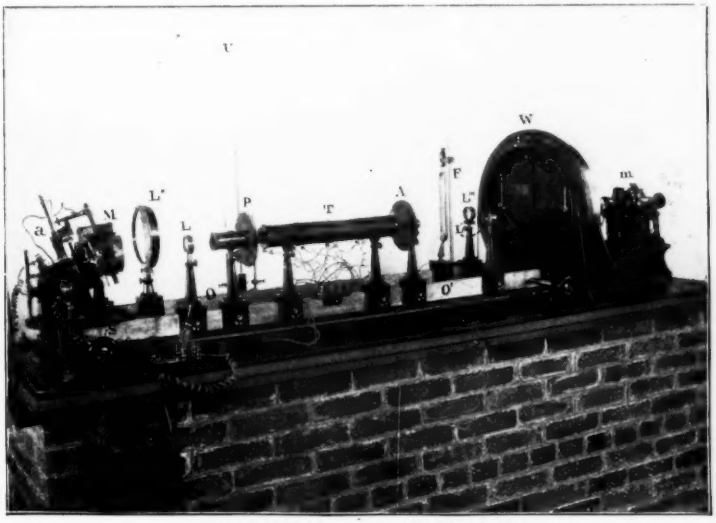
Nearly all of these investigations depend upon electrical apparatus, because they necessarily involve accurate measurements, especially of small intervals of time. The commonest problem is the determination of the velocity of projectiles, and for this purpose the Le Boulengé chronograph was long used—indeed, up to a very few years ago it was practically the only instrument in general use for this purpose, and it is still used for rough work. For accurate work, however, it is being rapidly displaced. In England the Smith chronoscope has been adopted in all the artillery laboratories, and in the United States the Crehore-Squier polarizing chronoscope has been installed in the electrical laboratory at the Artillery School.

The last-mentioned is in many respects an entirely new physical-laboratory apparatus, in which Faraday's discovery, that a magnetic field will rotate the plane of polarization of light, is applied to produce a camera shutter *without mass.*

The apparatus, resting on inverted T rails, O and O′, (traveling on rails V V′, moved independently by screws S S), firmly set on a pier, comprises an arc lamp *a*, and condensing lens L, the polarizer (a Nicol prism) P, the coil T (inclosing a tube filled with carbon bisulphide), the analyzer A (another Nicol prism) and the lens L′; the mirror M (which reflects the light from the arc lamp), a condensing lens L″, the tuning-fork F (which has a little piece of aluminum foil, perforated by a small hole, attached to one prong), and the magnifying lens L‴. The heavy cast-iron fly-wheel W, rotated by a small motor *m*, has mounted in it a plate holder, the sensitized plate of which, rotating with the wheel, acts as a receiver. The gravity switch U is merely a weight falling so as to make in succession two contacts, the first caus-

ing the material shutter of the camera to drop and expose the plate, the other starting the motion which we desire to measure.

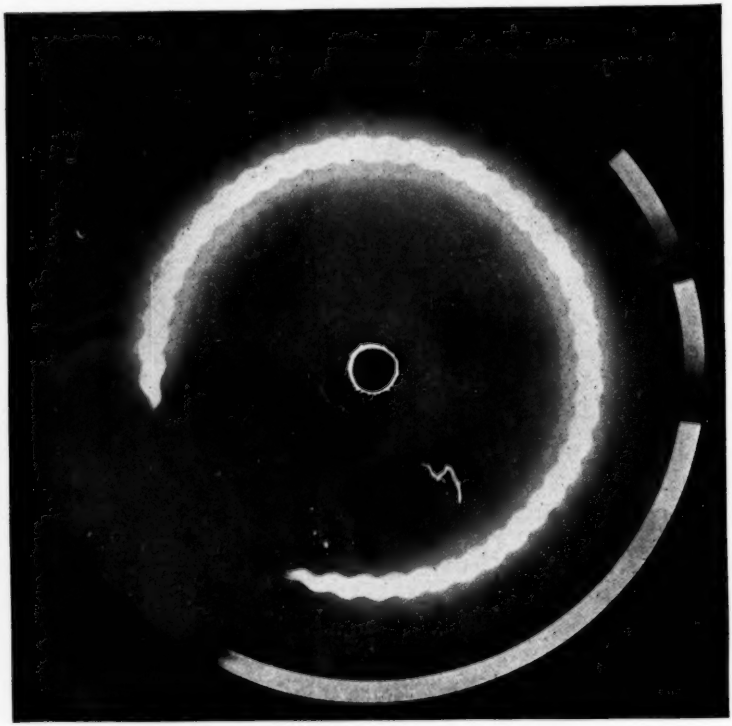
To conduct an experiment the lamp current is started, the polarizer and analyzer are set so as to produce darkness at the focus of the lens L′, a current is sent through the coil of the tube T, and in the passage of the beam of light through the carbon bisulphide (which is evidently in a magnetic field so long as the current passes through the coil) its plane of polarization is rotated through a certain angle, and light emerges from the analyzer; the motor is then made to rotate the plate, the fork is set vibrating, and the weight on the gravity switch is



SQUIER-CREHORE PHOTO-CHRONOGRAPH.

dropped. The dropping of the material shutter of the camera exposes the plate at a radial slit, which admits the light for the chronograph record, and also at a round opening, through which the light from the tuning-fork passes. The moving body (a projectile fired from a gun) is made to break the circuit at a series of wire screens arranged in succession in its path, contact being made automatically after each break. Now, whenever the current is broken the carbon bisulphide, being no longer in a magnetic field, loses its rotary power, and hence there is darkness, or a break in the chronograph record—in other words, the massless shutter has fallen and shut out the light; as soon as the circuit is closed again the massless shutter is opened and the light let in, and

so on. The tuning fork record of the light through the aluminum strip on the fork is continuous, and serves as the time scale, the number of vibrations between breaks being measured by counting the waves, and, as the rate of the fork is known, the time interval between breaks is readily determined. With this instrument the velocity of a projectile was measured at seven consecutive points inside the bore of a field gun.



CREHORE-SQUIER CHRONOGRAPH RECORD PLATE.

The necessity for electrical apparatus in all the departments of military science is therefore apparent, and a knowledge of electricity and its appliances is essential to-day, not only for the officer but also for the private soldier. Moreover, the field for the electrical engineer is continually widening, for, although the army is striving to make itself independent by educating its own men to take care of the necessary military apparatus, the science of electricity is continually invading the domain of military science through new passages, so that much of the work necessarily remains for the electrical engineer.

EDITORIAL COMMENT

According to appearances as we go to press, no Isthmian Canal bill will be passed by the United States Congress at this session. The immediate reason seems to be parliamentary, but it is greatly to be hoped that back of that lies a reaction to sober sense and an appreciation of the impropriety and folly of acting in so important a matter without a knowledge of the facts.

Before the matter comes up again the report of the Commission who have been studying the entire isthmus should be ready and available. The work, with the exception of some surveys on the ground, is substantially completed and the Commissioners have returned, but Admiral Walker very properly declines to anticipate in any way the drift of their conclusions, or to make any statement except that the Panama and Nicaragua routes have been thoroughly examined, and in addition, especially, the Atrato route—of which, by the way, a complete and exhaustive survey was made many years ago by John C. Trautwine, Sr. Admiral Walker says that the merits of each route have been fully recognised and the difficulties of each accurately weighed. For the nett result we must await the report.

Meanwhile, factionists are sedulously cultivating the popular impression that "Isthmian Canal" and "Nicaragua Canal" are synonymous expressions, although in other quarters it is hinted that Atrato may prove the "dark horse." May the best route win!

* * *

It would be a curious turn in politico-economical affairs if it should prove that Russia, in opening up Eastern Siberia and Manchuria by railway and telegraph, had been creating markets and engineering opportunities for the United States to seize. There are many suggestions, however, that this is not far from an accurate summary of the situation, and some patriotic Russians are disturbed over it, though it would seem as if Russia were not yet sufficiently self-supplying, as to her European territory, to do else than rely on outside producing countries for the development of her vast Pacific possessions.

Two things have probably combined to turn the attention of the United States toward this region—first, the Russian quest for railway materials for her Eastern lines, which have resulted in large shipments to Vladivostok from the Pacific Coast; second, the coincident direction of the attention of American manufacturers to the "Far-Eastern" markets, following the acquisition of the Philippines.

The expansion of Trans-Pacific commerce is destined to be one of the great features of the next few decades. Already it is foreshadowed in the huge fleet for the building of which James J. Hill is making plans and contracts. And in the creation and control of this commerce Japan, according to well-informed observers, is going to be a leading factor. We shall have more to say on this topic shortly in an illustrated article by Mr. A. H. Ford, who has lately returned from an extended tour of investigation and study of the Trans-Siberian and Chinese Eastern Railways.

* * *

In all discussions of cable routes across the Pacific it seems difficult to get rid of the idea that the military features are paramount, and that national control is of vastly more importance than questions of construction, operation, commercial value, and general feasibility put together. At the same time, it might be observed that no one factor is more powerful in conserving the peaceful relations between nations

than close commercial connection, and when industrial, manufacturing, and business relations are closely interwoven, political differences are very likely to be settled without recourse to the last resort of arms.

In the able discussion of the northern route between the extreme northwestern coast of the United States and the Philippine Islands, which was published in the issue of this Magazine for November last, it was pointed out that the shortest, or great circle, route possesses every advantage which could be desired. The distance is the shortest possible line between America and Japan, and hence to the terminus of the Trans-Siberian Railway; it is divided into a number of moderate stretches of nearly equal length and uniform depth; the line starts near the latitude of Paris and its highest point north is in the latitude of Aberdeen. The lowest temperature ever recorded at the northernmost point is 15° C. below freezing, and none of the landing places is troubled with ice, teredo, or coral. In short, the route is the ideal one for cable communication between America and Asia, and its construction would provide an international system, open to all nations, and hence not to be interrupted by any—a system built for the ends of peace, commerce, and industry, and by the furtherence of those ends one which would become a powerful factor in preventing war and the necessity for a military means of communication.

While such considerations may not appeal to those whose interests are bound up in matters military, yet they should appeal to the men who, above all others, have done the most to advance civilisation and progress—to the engineer, the manufacturer, the industrial manager of great enterprises; and it was to such that the northern route, from its inception, was expected to appeal.

* * *

One of the regular accompaniments of the international exposition of the present day is the series of congresses upon various branches of systematised knowledge, which has been found of increasing value with every succeeding gathering. In all such congresses the gatherings of engineers have proved of importance, not so much for the direct and immediate results which have followed as because of the broadening influence which is exerted upon the work of the profession at large.

Specialisation is undoubtedly the order of the day in engineering, as in other professions; but yet it is a well-known fact that many great advances in the arts have been made by those whose regular occupation is foreign to the subject in which success has been attained. This is but the natural result of too close application to the limited field of the specialist, which gradually gets the worker into a groove of ever increasing depth, from which he finds it more and more difficult to climb. A meeting with fellow-workers in allied branches, however, invariably acts to broaden the field of view, and a congress at an international exposition is still more effective in preventing the excessive conservatism which is fatal to all real progress.

It will be a matter of interest to watch the outcome of the extensive series of congresses upon engineering and other scientific subjects which are to be held in connection with the Paris Exposition, and to compare the immediate with the ultimate effects.

That many important and valuable papers will be presented and discussed is to be expected, but it may well be asserted that the broadest influences which will result are those which will not be recorded in the transactions nor published in the technical press—the influences which will pass from man to man, from specialist to specialist, showing each the immense field outside his own necessarily limited area, and stimulating him to better, truer, and more effective work within the range which he has mastered.

International expositions are primarily supposed to be held for the direct advance of commerce, trade, manufactures, and all that is included in the advertising character of exhibits and display; but it is now

generally admitted that the effect which they have upon general development of social and intellectual progress is an equal function, and one which may ultimately overshadow the material features to an ever increasing extent.

* * *

The final acceptance of the Holland submarine boat by the United States Government, and the probability that a number of others will be constructed, gives some reasonable assurance that a fairly satisfactory solution of the problem has been attained, at least within reasonable limitations. There is no doubt that the trials were made as stringent and searching as the conditions would permit, and that, had the boat not responded to the requirements in a satisfactory manner, it would not have been accepted.

Under these circumstances it seems probable that in the next conflict between naval powers the submarine boat will have to be reckoned with as one of the unknown factors in the problem, which means that the hold of the engineer upon naval warfare is to be made stronger than ever in the immediate future. It cannot for a moment be supposed that the use of such vessels will be limited to any one nation. France has already been experimenting with them, and has reached a point where practical success seems assured, and England will not be long behind; and with the experience which will come from practice in manœuvring and control, a new series of tactics will be evolved which, for harbour defence at least, must modify very greatly the accepted methods. THE ENGINEERING MAGAZINE will shortly present a comprehensive review of the submarine boat by Admiral Hichborn, Chief Constructor U. S. N.

It has been suggested that it is not only for harbour defence that the submarine boat is adapted, since small boats of this kind might be carried, like large torpedoes, upon cruisers or swift consorts, and launched only when within practicable working radius of the enemy. Here again it is the engineer who will have to stand the brunt of the battle, and sealed up in the automobile torpedo, with every risk of disaster and death from an invisible enemy, he will decide the fate of battles and of nations.

It has generally been argued that the development of destructive methods must ultimately result in the abandonment of warfare, and the argument is doubtless correct. The submarine boat is the latest step in a long history of evolution from club, bow and arrow, musket, fire-artillery, high explosives, and rapid-fire guns, and in the vista ahead the aerial destroyer may be dimly discerned, and beyond—perhaps, peace. It may be a radical way of healing the disorders of the human race, but it has its analogy in the science of the healing of diseases of the individual, and if one of the functions of the engineer is to act as the surgeon of humanity, let him be provided with the keenest and most effective instruments, that he may do his work promptly and well.

* * *

We take great pleasure in giving space to the subjoined communication from The Parsons Marine Steam Turbine Co., Limited, referring to a quotation used by Mr. A. E. Outerbridge in THE ENGINEERING MAGAZINE for March:

The Editor of The Engineering Magazine.

Sir: Our attention has been drawn to an extract from the *Marine Review*, Cleveland, O., of the 21st December last, which was reproduced in your issue for March, relating to the report of "Lieut. Harold P. Norton, of the Navy, who is Inspector of Machinery for the United States Cruiser 'Albany' at the Armstrong Shipyards, Newcastle-on-Tyne, England."

We scarcely think that Lieut. Norton can have forwarded to his Government such a report as that which is alleged by the *Marine Review*, as it conveys in somewhat strong terms an impression that he had not received due courtesy on the occasion of his visit to these Works, and we desire emphatically to state that Lieut. Norton has received every possible courtesy both from Mr. Parsons and the Officials of this Company, with the usual

limitation, naturally imposed, of not showing Lieut. Norton everything in relation to work in progress and the turbine-propelled destroyers in course of construction, one of which—the "Viper"—is for the British Admiralty.

Our sole object in writing this letter is to remove the strong impression conveyed by the article which you quote that anything but the utmost courtesy has been shown to Lieut. Norton.

We are, sir, yours, etc.,

Pro THE PARSONS MARINE STEAM TURBINE CO., LIMITED,

(Signed) C. A. PARSONS,
Managing Director.

We trust that Mr. Parsons is mistaken in thinking that any intimation of discourtesy was intended by the original writer of the paragraph in the *Marine Review*. We are at least very certain that no intention of conveying any such intimation existed in the mind of Mr. Outerbridge or in the office of this Magazine. The point sought to be made was merely that Lieut. Norton was not permitted to make any close or detailed inspection of the motive power of the "Turbinia" and the "Viper," and this seems to be undisputed.

* * *

Those who have had occasion to undertake the translation of technical books or even to examine technical journals, in English, French, or German, have felt the great necessity for a really good technical dictionary.

It is not that there are no technical dictionaries in modern languages now on the market, but they are so entirely unsatisfactory that few care to use them, nearly everyone finding that the imperfect assistance obtained from a general dictionary is preferable to the incongruities and absurdities with which the so-called technical dictionaries abound.

It is not surprising that this should be the case, for the terms used in the workshop, the laboratory, the mine, and the field are generally arbitrary, and, in many instances, literally untranslatable, so that what is needed is not a translation, but an equivalent expression for the term so expressive to the original user and so meaningless when laboriously and literally translated by the foreign reader.

Admitting the necessity for a really satisfactory technical dictionary, the question arises: By whom can such a work be produced?

It must be the work of many hands, not only of those expert in the languages involved, but in the intimate practical work of the various departments of applied science which constitute engineering, and this, too, in the various languages included. Since the expense involved in producing such a work, if done in the ordinary manner, would probably exceed the returns to be expected from the sale of the book, some other method must be adopted if a thoroughly satisfactory result is to be secured. Such a method might be found as follows:

Let the various national engineering societies, the Institutions of Civil and Mechanical Engineers in England, the American Societies of Civil and Mechanical Engineers, the Institutions of Mining and Electrical Engineers on both sides of the Atlantic, for the English language, unite with the Société des Ingénieurs Civils de France, and with the Verein deutscher Ingenieure and the Oesterr. Ingenieur und Architekten Verein, and such other organisations as might be available, to apportion the work among their various members, each member agreeing to provide the correct technical definition of terms submitted in his special line of work. The preliminary work of translation could be done by ordinary translators, hired by the publishers, illustrations of all articles being provided, so that a knowledge of the several languages need not be possessed by the experts, and the result of this work should, when revised by a competent editorial committee, be the production of an international technical dictionary really worthy of the name.

REVIEW OF THE BRITISH PRESS

The Plateway System.

THE interesting address of Mr. Alfred Holt before the Students' Engineering Society of University College, Liverpool, upon the plateway system of transport for merchandise, is published in full in the *Automotor Journal*, and some of the points which are forcibly put in the address are here abstracted.

The root of the whole matter of transport lies in the fact that a disproportionately large portion of the cost is in the handling, and that even for long distances it costs more to unload the merchandise, reload it on a wagon and haul it to the warehouse, than it did to convey it many miles on a railway. The remedy for this is so obvious that it is surprising that it has not been adopted long ago; it consists simply in so constructing the vehicle and the roadway that the former can be hauled upon an ordinary street or road as well as upon the track, and can thus be taken from the train at any point and hauled by horse or other traction directly to the spot where the goods are wanted.

Mr. Holt's paper considers almost altogether the conditions attending transport in Lancashire, especially in connection with the hauling of merchandise between Liverpool and the great manufacturing cities in the vicinity. The heavy lurry has long been used for horse haulage in these localities, and it is proposed to use a similar vehicle, with two modifications, for the plateway. In the first place, the wheels would be made without flanges, thus permitting the vehicle to be hauled on streets and common roads as usual, and, secondly, couplers and buffers would be provided, and the shafts made removable, so that a number of such lurries, having been hauled by horses to a point on the plateway, might be made into trains and pulled by a steam or electric locomotive to the distant destination, there to be uncoupled and hauled singly to their respective places. The change in the wheels would require the flange to be made upon the track, and it is proposed to lay the plateway along the public highway, all other vehicles having the privilege of its use, since the track could be vacated or resumed at will. A speed of 10 to 12 miles an hour is considered permissible, and it is evident that a large volume of merchandise could be steadily and economically transported in this manner.

The criticism may be made that the speeds above mentioned are too slow to meet modern conditions, but, as Mr. Holt well remarks: "Slow speeds do not necessarily mean slow delivery." Merchandise may be hauled very rapidly for a long distance only to be delayed on a siding at the terminal while the slower means of transport is catching up to it.

The question of vehicles may take altogether a different form from that existing with the railways, the carriers providing their own rolling stock, and the plateway company providing the way and the hauling-engines, taking a toll for the service rendered.

"The practical mode of carrying goods by the plateway would be as follows:

"The lurry being loaded at the ship's side or warehouse in Liverpool, would be horse-drawn exactly as at present to the nearest plateway lines, placed on them if convenient, or at any rate near to them, the long horizontal shaft-bolt would be withdrawn, and the horse would be driven off, carrying the shafts with him. The iron coupling frame would then be unhooked from under the fore body of the lurry, and one end of a rope made fast to it, the other end carried either to the hinder part of the engine or of the preceding lurry, or else taken to a live capstan, and by one of these means the lurry would be pulled into position, the short vertical coupling bolt being then dropped in, the transformation would be completed. Mechanical traction by steam, or preferably by electricity, would then convey it as part of a long train, we will say, to Manchester, where horses, which would be standing

waiting, having brought other lurries from Liverpool, would be led up, the coupling frame would be again hooked up under the fore-body, the shafts attached, and the lurry again horse-drawn to destination at either mill or warehouse, its load never having been touched.

"A plateway can hardly be said to have a terminal station at all, for it really ramifies out to nothing at docks, warehouses, or private yards, or even in farmers' fields, but what would represent a terminal station would be entirely different from that of a railway. No goods having to be handled there, all cranes, wharves, warehouses, etc., would disappear; a long narrow unroofed space being all that would be wanted; an arrival line flanked by a road on one side, and a departure line similarly flanked on the other, and between them a central line to enable the locomotive to get from one end of the train to the other. No lurry would be allowed to enter till it was ready for the road, nor would any be allowed to remain on the arrival line. All the labour required would be that of a few men to couple up the lurries into trains, ready for the locomotive, or to break up the trains and attach the horses. Standing room for lurries is not required—the streets and private yards perform that part of a railway station's duty; but standing room for waiting horses might be necessary."

Electric Touch.

THE researches of Professor Jagadis Chunder Bose, of the Presidency College of Calcutta, in the domain of electro-physics, especially in connection with the influence of electric waves upon various materials, have resulted in some valuable contributions both to the theoretical and practical branches of electrical work.

Nearly a year ago Professor Bose made a communication to the Royal Society upon the behaviour of various materials in the coherer, this being the result of a systematic study of the properties to which coherer action in space telegraphy may be due, and in that paper the theory of the chemical nature of the action was advanced. The paper was reviewed in these columns at the time, and now we have, in a further communication to the Royal Society, an account of later experiments and deductions.

The term "coherer" appears to be unfortunate to a certain extent, since it conveys the idea that the particles in the glass tube have their resistance diminished under the influence of an electric wave by somehow sticking together and forming a continuous conductor. While this may be true in some instances, Professor Bose shows that in numerous cases the effect of the electric wave is to cause an increase in resistance, that is, a "de-coherence."

"In the former paper it was shown that though many substances exhibit a diminution of contact resistance, there are others which show an increase of resistance—an increase which in certain cases lasts only during the impact of electric waves, the sensitive substance automatically recovering its original conductivity on the cessation of radiation. There are thus produced two opposite effects, either an increase or diminution of resistance, depending on the nature of the substance. The effect of the increase of contact resistance is not an exceptional or isolated phenomenon, but is as normal and definite under varied conditions as the diminution of resistance noticed in the case of iron filings."

The earlier investigations showed that the sensitiveness of the substance resided upon the surface layer, the nature of the substratum having little or no effect upon the result. A substance which exhibits a strong diminution of resistance, if coated with an extremely thin layer of a substance of the other class, then exhibits an increase of resistance. For this reason Professor Bose has given these effects the significant name of electric "touch," and in his discussion of his experiments he brings out some interesting and possibly important points.

The whole subject is considered as one of molecular physics, occupying the borderland between physics and chemistry, and affords not only an important verification of the identity of visible and electric radiation, but also tends to establish the continuity of all radiation phenomena. The theory of coherence, of Professor Lodge, was supposed to explain the action to a certain extent, but fails to account for

the increase of resistance in the case of certain substances, such for example, as potassium. Professor Bose offers the theory that there is a molecular action produced by the influence of the electric waves, of the nature of an allotropic modification due to the difference in the atomic or molecular aggregation. This effect is modified by the chemical nature of the substance. Not only does the nature of the material affect the positive or negative nature of the resistance, but in some instances there is a reversal of resistance, depending upon the intensity of the radiation. Thus with a receiver containing freshly-powdered arsenic there was found to be an increase in resistance when a radiator of great intensity was placed close to the tube. As the radiator was removed the influence became weaker until a critical distance was reached, when the influence was zero, beyond which the action was reversed, and a diminution of resistance was produced.

The effects of tapping to overcome the condition of "fatigue" into which the substance in the coherer gradually falls, are also discussed, and the experiments for a number of substances are plotted in the form of radio-molecular oscillation curves which show very clearly the nature of their behaviour.

Summing up the results of the experiments, it is shown:

(1) That ether waves produce molecular changes in matter; (2) that the molecular or allotropic changes are attended with changes of electric conductivity, and this explains the action of the so-called coherers; (3) that there are two classes of substances, positive and negative, which exhibit opposite variations of conductivity under the action of radiation; (4) that the production of an allotropic modification depends on the intensity and duration of incident electric radiation; (5) that the continuous action of radiation produces oscillatory changes in the molecular structure; (6) that these periodic changes are evidenced by the corresponding electric reversals; (7) that the "fatigue" is due to the presence of the radiation product; (8) that by means of mechanical disturbance or heat the radiation product can be transformed into the normal form, and by so doing the sensitiveness may be restored.

Although these investigations have been conducted in the spirit of pure science, and presented in the form of an academic paper, the important bearing which they have upon the development of space telegraphy is evident, and improved instruments and methods of telegraphing without wires may be expected to result directly from practical applications of the principles above laid down.

The Wastefulness of Chimney Draught.

In a recent editorial discussion of the question of the various methods for the utilisation of waste heat, the *Engineer* considers among other features the wastefulness of the usual method of producing draught by the ascent of heated air in a chimney.

Taking the boiler as the wasteful member in a steam plant, its efficiency varies from 60 per cent. in a bad boiler to 80 per cent. in a very good one, these proportions of the heat produced by the combustion of the coal being realised in steam available for the engine in each case.

"The difference may be said, without greatly stretching the truth, to go up the chimney. It is not to be disputed that much of the waste heat might be caught and utilised; but there are reasons why it is not so caught. In the first place, the gases must be hot when they go into the chimney, or there will not be a draught.

"As a matter of fact a draught got in this way is the most expensive possible, save one. The exception is a steam jet in the chimney. A fan can be run for about one-tenth of the power represented by the waste heat required to command a good draught. A tall chimney will cost from £1,000 to £5,000—very much more than will a fan plant. But the fan is not used and the chimney is, largely because it is essential to discharge the products of combustion high up in the air over the roofs of surrounding houses. This necessity must be taken into account in so far as factories are concerned, but it does not hold good of steamships; yet we believe that in most cases a chimney stack 100 feet high would be sufficient, because with a fan combustion could be more easily controlled than is possible with a chimney, to the end of preventing the giving off of smoke."

This practice can only be expected in newly constructed works, since it is hardly to be expected that steam users with great chimneys and large batteries of boilers will be found willing to make such a considerable change.

Various methods have been devised for utilising the waste heat before it passes out of the chimney, the best-known of these being the Green economiser, but this device is large and expensive, often exceeding the boiler in heating surface, and is altogether unsuited for use on shipboard. Heating coils, however, might be placed at the base of the chimney and in the smoke chambers in such a manner as to return much of the waste heat to the boilers with the feed water.

Other economies might be effected by the use of mechanical stokers, heating of air, air regulation, and close compliance with the theoretical conditions of combustion, but among them all probably the greatest economy would be obtained by the reduction of the loss due to chimney draught.

Boilers for Naval Vessels.

THE discussion upon the well-worn subject of water-tube boilers for naval vessels continues, but on modified lines, and a recent editorial in the *Engineer* shows very clearly the changed sentiment in this respect. Formerly it was water-tube versus cylindrical boilers, but now it is only a question of how to secure a satisfactory water-tube boiler, the Scotch boiler being altogether out of the race. "The Scotch boiler is a thing of the past. It is no more likely to be used again than is the old-fashioned low-pressure box boiler in our ships about the time of the Crimean war."

But the water-tube boiler itself is not an unmixed blessing. There are certain primary conditions to be fulfilled on a naval vessel, and the best boiler is that which most nearly meets them.

"It is all important that the nature of these ruling conditions should be fully comprehended. The primary condition is, that, with a given weight per ship of coal, boilers, and water, the highest possible horse-power may be got. The coal we may regard as a constant. This is not strictly true; but the assumption that it is will not affect what follows, save in so far as it tends to simplify matters. We have then a certain weight for the boilers, and the water in them. The weight of a boiler is made up by the shell, the heating surface, the stays, the fire-bars, and the fittings. If, now, we can so use all our materials, and so design our boiler that nearly all the metal shall be heating surface, it is obvious that, other things being equal, we shall have a much lighter boiler than one in which we have a large quantity of steel disposed in the shape of very heavy shell plates which are not heating surface at all. It is also obvious that so far the condition can only be satisfied by a water-tube boiler. Again, such a boiler will contain the minimum quantity of water. Furthermore, the steaming power of a boiler depends upon the quantity of coal that can be consumed on its grates; and it is a matter of common knowledge that the more slowly the coal is burned, and the less localised the heat, the longer will the boiler last, and the greater will be its economy. Here, again, the water-tube boiler has all the advantage on its side, because the grate may be made almost as large in area as we please; but in the Scotch boiler the dimensions of the grate are bound by limitations which cannot be passed. It is clear, therefore, that from whatever side we regard the question, the water-tube boiler complies with the conditions that for a given weight of steel and water will supply more steam per hour than the Scotch boiler."

The Belleville boiler was adopted for the British navy because it had already been extensively used by other nations. Precedent ruled, although it was evident to many engineers that the Belleville design was not all that could be desired. The steam generated in the lower tubes must work its way up through the water in the tubes immediately above, thus necessarily producing foaming, and involving some form of subsequent drying before the steam is fit for use.

Pitting and wasting of the tubes have caused much trouble in practical operation, and it is quite possible that this is in part due to frothing and defective circulation. Whatever the various causes of dissatisfaction, there is little doubt that, while the water-tube boiler is undoubtedly the boiler

of the present and future, it should be a better water-tube boiler than any of those now in use.

So far as the practice of other countries is concerned, it is evident that the Belleville is not the only boiler which is thought suitable for naval use. The Babcock & Wilcox boiler has given good service in vessels of the United States navy, and the Niclausse boiler has been extensively introduced in naval vessels of France, Italy, the United States, and other countries, for powers ranging from 10,000 to 20,000 horse power; while in the Dutch navy the Yarrow boiler has been adopted.

Surely with the experience thus developed, the design of a reliable water-tube boiler should be sufficiently removed from the realm of experiment to enable the conditions to be examined systematically and a steam generator designed in the same manner as an engine or a machine tool.

Condensation in Steam-Engine Cylinders.

ONE of the largest losses in the conversion of heat into power by means of steam is known to be that due to condensation in the cylinder, and many theoretical and practical discussions have been given to the problem of reducing this loss.

The subject naturally presents many difficulties, not the least of these being the impracticability of seeing the interior of a steam cylinder under normal working conditions, and the necessity of assuming to a great degree exactly what goes on within it. It has usually been assumed that the chilling action of the cylinder walls condenses a portion of the incoming steam, forming a film of water which is subsequently re-evaporated during the expansion after cut-off.

In order to remove as much as possible the uncertainty concerning the nature of the action of steam in a cylinder, Mr. Bryan Donkin devised, a number of years ago, an instrument which was named by Hirn a "Revealer," and which was intended to permit the production, in a glass cylinder connected to the steam cylinder of an engine, of a visible evidence of the phenomena of cylinder condensation. This instrument has been subsequently much improved, and in a paper recently presented before the Institution of Mechanical Engineers, Mr. Donkin gives a description of it, together with an account of some observations made by its assistance.

The revealer is designed to reproduce as nearly as possible, and render visible, what takes place inside the steam cylinder. It consists of two cylindrical glasses, one inside the other, fixed concentrically, the space between them forming a hot-air jacket, and the inner cylinder connecting with the steam cylinder of the engine under observation, by means of a short, straight pipe, a stop-cock of direct, wide opening being provided. Inside the inner glass is a small cast-iron cylinder, and all the external metal and glass surfaces, with the exception of the openings for observation, are well covered with non-conducting material to diminish radiation.

Although the conditions cannot be made exactly the same as in the interior of the cylinder itself, Mr. Donkin maintains that the effects of condensation, as shown by the revealer, may be within 85 to 95 per cent. of the truth, and all results can be accurately seen, magnified, and studied. By the use of a ruled scale on the surface of the interior cast iron cylinder, giving areas of one square milimetre, it is possible to estimate, under suitable magnifying power, the sizes of globules of steam, with a useful comparative degree of accuracy.

Mr. Donkin describes in detail a number of observations made on a compound beam engine, working condensing, at a speed of about 35 revolutions per minute, both with the revealer as above described, and with a modified form in which a thermometer was inserted into a cavity in the interior cast-iron cylinder, enabling the temperature to be compared with that of the steam as computed from the pressures shown on the indicator diagrams.

The general behaviour of the steam was revealed as follows, on the low-pressure cylinder.

"Commencing with the steam stroke, the first result observed, when the steam is admitted to the revealer, is a light and not very dense cloud or white fog coming up from the engine cylinder. This is precipitated on to the hot internal glass and cast-iron walls, and is seen as very fine globules or particles of moisture or condensation. This cloud is sufficient to obscure a light

placed on the opposite side of the revealer. Re-evaporation then very rapidly follows before the end of the steam stroke. On the opening of the exhaust valve, the cloud passes quickly off into the cylinder, and the glasses become quite transparent.

"Each time the steam enters, a large number of very small globules, at about equal distances from each other, are immediately seen upon the glass walls. These are from 1-20th to 1-25th of a millimetre in diameter, or less, and are distributed in a fairly uniform manner over the entire surfaces. The time occupied by the deposition of the globules, and their re-evaporation, is perhaps a tenth of a second. Before the end of the steam stroke, the duration of which is about half a second, and before the exhaust valve opens, the smaller globules, 1-25th of a millimetre in diameter, are all evaporated. During the exhaust stroke, the larger globules are also re-evaporated, but not so quickly. The internal surfaces are sometimes quite dry, and at other times a few drops of moisture remain on them."

A similar action takes place in the high-pressure cylinder, the only marked difference being in the size of the globules, these being much larger in the high-pressure than in the low-pressure cylinder. The influence of the jackets was clearly seen in the revealer, and experiments made with artificial cooling showed the instruments to respond promptly to any changes in conditions.

Although the experiments have as yet not been extended to quick-running engines, the information already obtained confirms to a great extent what had already been supposed to take place in the inside of a steam-engine cylinder. One result, however, seemed to prove that there does not exist any thin film of condensation water on the internal surfaces of steam-engine cylinders, whether the cylinder is hot or cold, the moisture always appearing in the form of drops or globules. The only effect of differences of temperature between the walls and the working steam seems to be the difference in size between the respective globules of water.

Mr. Donkin proposes to continue these interesting experiments, and they will doubtless also be supplemented by those of other observers, thus materially extending our knowledge of the important subject of cylinder condensation.

Power Required by Machine Tools.

THERE have been many attempts to determine the amount of power to drive machine tools when performing various kinds of work, most of these investigations having been made with the aid of special forms of dynamometers interposed between the machine and the motive power. In some instances the power has been measured by comparing consecutive indicator diagrams taken from the engine, the condition of the work on the machine being noted at the time of the taking of the diagram. With the introduction of independent electric driving, however, the measurement of the power absorbed has become materially simplified, and by the use of automatic recording ammeters the electric energy supplied during any operation may be determined very conveniently.

A number of experiments have been made at the Atlas Works, Sheffield, under the supervision of Captain Tressider, upon the power consumed by electric motors in driving heavy tools, and a summary of the results, together with diagrams from the recording instruments, is given in a recent issue of the *Engineer*. The ammeter gives only the amperes, and from this the power in watts is deduced on the assumption that the voltage remains constant. This latter assumption is not strictly correct, but the fluctuations are not large enough to affect the general value of the results, and in the tests it appears that a fairly constant pressure of 220 volts was maintained.

The general system of driving involved the use of raw-hide pinions on armature shafts, driving steel spur wheels on driving shaft, from which direct belting connected to the machine pulleys. The motors were principally of the standard sizes of twenty and twelve horse power, with a few smaller sizes for special purposes, and their efficiency was estimated at 85 per cent., or four amperes at 220 volts required for each brake horse power.

These motors were employed in driving heavy planing, drilling, and slotting machines, working upon very tough steel, of a breaking strength of 45 to 60 tons per

square inch. This material does not permit of the maximum power being put into the machines, since the limit is not the strength of the machine, but the edge-holding power of the tool steel.

The diagrams from the recording instruments show the irregular demands of the various tools very clearly. Planing machines, especially, are least well adapted to separate electric driving, on account of the large and constantly recurring variations of power demanded. For this reason it is considered better to arrange such machines for group-driving, and until motors can be made to run in parallel at all loads, at least three planing machines should be driven by one motor.

"The separate driving adopted in the present installation gives no trouble; but it will be seen from the diagrams that the conditions of a separately driven planing machine are most unfavourable to high motor efficiency. Several methods have been adopted for cutting down the "peaks" of the diagrams. In addition heavy fly-wheels, with a periphery speed of nearly 5,000 feet per minute, have been adopted on the armature shafts to modify the speed variations; and for the same reason all pulleys on the driving shafts for planing machines have been made of cast iron, and especially heavy in the rim."

An examination of the data given for the various tools will be of interest. Thus with a heavy double-screw planing machine the power required for starting appeared to be nearly the same whether the machine is empty or loaded, ranging from 22½ to 24 horse power, while during the stroke it required 7½ h.p. empty, and 12 h.p. when cutting an 8 ton plate. A rack driven planer of similar character showed a consumption of considerably less power than the screw driven machine, but the jerky character of the motion renders it less desirable as a tool. A large radial drill consumed 2 h.p. running empty and 3 h.p. drilling a 3⅜ inch hole, while the tapping of such a hole consumed from 3 to 6½ h.p., the variation in the latter case being due to the unequal amount of work done by the successive taps. A large slotting machine, taking a cut 1¼ inch wide with 1-80 inch feed, required 15 h.p. during the cutting stroke, and 10½ h.p. for the return, against the unbalanced weight of the tool arm.

These figures are, of course, of only general application, although it will be interesting to compare them with similar service as measured by the dynamometer. The method of measuring power, however, appears to be susceptible of wide application, particularly in mechanical laboratories and research departments of engineering schools, and training in electrical measurement might thus be combined with the accumulation of a large amount of data of great value to the designers and users of machine tools.

Portable Pneumatic Tools.

THE idea of bringing the tool to the work rather than that of bringing the work to the tool is by no means new, but its practical execution has been limited by the progress of methods for the convenient transmission of power. Many years ago portable drills, driven by rope gearing with a weight take-up in a slack loop of the rope, were introduced. These were followed by the use of the flexible shaft, still employed for short connections, but at the present time the principal methods employed for driving portable tools are electricity or compressed air.

Portable pneumatic tools have been more extensively used in the United States than elsewhere, and a recent paper by Mr. Ewart C. Amos before the Institution of Mechanical Engineers is devoted mainly to a discussion of some of the convenient and effective devices which have been produced for enabling chipping, riveting, caulking, drilling, and various other operations to be performed upon any large piece of work, either in position, or upon the shop floor.

The most important of these tools are those of the hammer type, in which a plunger is given a very rapid reciprocating motion in a cylinder, the latter being provided with such handles as will enable the workman to hold it up to the work. With the exception of the rotating motion, such a tool resembles a miniature rock drill, and the interior construction is not greatly different. The air is delivered through flexible tubing, so that the tool can readily be taken to any point about the work, and by the use of chipping or caulking chisels

the work can be done at a rate entirely out of the question by any hand method.

The so-called "valveless" hammers are are those in which there is no independent air valve, its place being supplied by passages in the plunger itself. These hammers have a short but very rapid stroke, sometimes reaching 10,000 to 20,000 strokes per minute, and are suited for such work as beading flues, light caulking and chipping, and carving in stone. The valved hammers have a longer and less rapid stroke, and deliver a more powerful blow, and are adapted for general and heavy chipping, caulking, and riveting. The usual speed for such tools is from 1,500 to 2,000 blows per minute, although they can be driven much faster.

It is an interesting and well-known fact that the nature of a blow, whether light or hard, produces an effect on various materials apart from the actual work done as measured in foot pounds. Thus, 10,000 small blows, representing a certain number of foot pounds, might fail to produce a desired result, which a smaller number of heavy blows, representing less energy in foot pounds, might effect.

Mr. Amos gives detailed illustrations and descriptions of a number of well-known hammers, with sizes and air consumption, but calls attention to the fact that the air consumption will differ greatly in the hands of different workmen, and that the air consumption is not alone indicative of the efficiency of a tool. It is also necessary that a hammer should be selected of suitable weight for the work which is to be performed. No tool can be adapted to all classes of work. It is not uncommon to find operators attaching blame to a tool on account of its failing to do its work when the real cause of failure is due to the application of the wrong tool.

Riveting has been successfully performed by compressed air tools for some time, the earlier machines having been of the type operating by squeezing. This work can also be performed by the pneumatic hammer by having it fitted with suitable snaps, and in the hands of skilful operators these machines are very useful, owing to the limited space in which they can be used. Yoke riveters are also extensively used, one arm of the yoke being fitted with what is practically a percussion hammer, while the other is a solid holder-up. Both types are fully illustrated in the paper of Mr. Amos. He also shows various forms of pneumatic drills, hoists, and other tools, and gives an interesting table showing the saving in time and labour by the use of the tools as demonstrated at important railway shops and machine works in various parts of England.

"When making comparison of the cost of work as between pneumatic tools and hand labour (and it must be borne in mind that they compete largely with hand labour) it is necessary to take into consideration three points: (1) That with the same sized shop and the same standing expenses in the form of rent, rates and taxes, and wages bill, a very great deal more work can be turned out in the same time. (2) That although against this there must be set off the cost of producing the compressed air, yet even supposing this equalled the cost of manual labour (which it does not) there would still be a considerable saving for the reason given in item (1). (3) That with hand-labour, especially in riveting, caulking, and place drilling, work can only proceed at a comparatively slow rate, however many men be employed, and however closely together they work. This frequently becomes a serious matter in ship and bridge building, railway works, etc., and even were the cost double that of hand labour, other advantages as regards speed, etc., would outweigh it; but as a matter of fact, when properly carried out, the saving is very considerable, and it is in the author's opinion only a question of time, and that not very far distant, when every engineering shop will find it absolutely necessary, if it wishes to keep in the van of progress, to adopt the pneumatic or some similar system of portable tools."

REVIEW OF THE CONTINENTAL PRESS

Hammer-Blow in Water Pipes.

THE action of the so-called "hammer-blow" in water mains has made itself apparent so often that the effects, at least, are well known. Precise knowledge of the causes and actual magnitude of these shocks, however, has been lacking, the experimental study of the subject having been very slight, until recently. Some experiments made by Professor R. C. Carpenter, of Cornell University, at Ithaca, gave data concerning water-hammer in small pipes, but apart from these, the subject had not been scientifically investigated until some recent, and very valuable experiments made in Russia.

These experiments, made under the supervision and at the instance of M. Nicholas Simin, Chief Engineer of the Moscow Waterworks, and conducted in detail by Professor N. Joukowsky, of the Moscow Imperial Technical School and the Moscow Imperial University, are discussed very fully in a paper presented by Professor Joukowsky before the Imperial Academy of Sciences of St. Petersburg, and from this paper the following abstract is made.

The observations were made upon pipes of 2, 4, and 6 inches in diameter, these being laid upon the ground and connected with the 24 inch main of the Moscow water system; valves at the ends of the pipes enabling the flow to be interrupted very quickly to produce changes in the hydrodynamic pressure in the pipes. The results of the tests are especially interesting, since they show what had hitherto not been known, that all the phenomena of hydraulic shock may be explained by the formation and propagation of shock-waves in the pipes, these waves being due to the compression of the water and the extension of the walls of the pipe.

After a review of the various theoretical studies which had previously been made of the action of shock in water-pipes, including the account of the experiments of Professor Carpenter, Professor Joukowsky goes on to describe the arrangement of the apparatus used in making the tests from which his deductions were made. The pipes were laid in the yard adjoining the Alexiew pumping station, the lengths being as follows: 2 inch, 2,494 feet; 4 inch, 1,050 feet, and 6 inch, 1,066 feet. The pipes were so laid that the terminals came close to the points of departure from the large main, thus enabling the same observers to control the closing of the valves and the observation of the instruments at both ends. Arrangements were provided for weighing the quantity of water discharged from any pipe in a given time, and by previous calibration the velocity required to discharge a known weight of water had been determined, so that this weighing of the water gave an accurate measure of the velocity in a pipe at any experiment. Several devices were employed for determining the pressures. A series of Bourdon pressure gauges were placed at known intervals along the lengths of the pipes, these gauges being provided with friction indicators, showing the maximum pressure to which the needle attained for any test. The rapidity of propagation of the shock-waves was measured by a Marey chronograph, recording, by means of electrical connections, the time of shock at points 700 feet distant, while the rise and fall of pressure at various points in the pipes was recorded by a special arrangement of the Crosby indicator. The corrections required in the use of these instruments are discussed in the paper, and the readings are tabulated and specimens of the diagrams given.

It is impossible with the limited space here available to go into the details of Professor Joukowsky's investigation, and for this the reader must be referred to the original paper, but the conclusions are of sufficient importance to be given in full.

1. The hydraulic shock is propagated along the pipe with a constant velocity, which, so far as could be observed, is independent of the magnitude of the shock. This velocity is dependent upon the ma-

terial of the pipe and upon the ratio of the thickness of its walls to the diameter of its bore. For ordinary cast-iron water pipe this ratio diminishes somewhat as the diameter increases, and hence the velocity of the shock-waves is somewhat less for large pipes than for smaller ones. For pipes of moderate size, 2 to 6 inches bore, the velocity is about 4,200 feet per second, and for larger pipes, say 24 inches bore, it is about 3,290 feet. The velocity of the shock-wave is the same whether the shock is produced by suddenly arresting the flow at the discharge of the pipe, or by suddenly raising the pressure at the beginning.

2. The hydraulic shock acts with uniform force upon the length of the pipe. Its magnitude is proportional to the loss in velocity of the flow of the water and to the velocity of propagation of the shock-waves in the pipe itself. For ordinary cast-iron pipe of 2 to 6 inch bore we have for each foot of velocity lost by the water a shock of about 4 atmospheres, while for a pipe of 24 inches diameter the shock is about 3 atmospheres.

3. The existence of a periodical oscillation of a shock in a water pipe is indicated by the reflection of the shock-wave between the beginning and end of the pipe.

4. The flowing water has apparently no influence upon the shock, this appearing to be dependent only upon the loss of velocity. The shock is reflected just the same in a pipe through which water is flowing as in a vessel containing stationary water, other conditions being equal.

5. A dangerous increase in shock may appear in the passage of the shock-wave from a pipe of large diameter to one of smaller diameter. In such a case the force of the shock, when it reaches the closed end of the pipe, is doubled, and as this doubling may be repeated several times, the pressure may attain great magnitude.

6. The simplest method of preventing shocks in water pipes is to introduce devices compelling the slow opening and closing of valves and cocks. For this purpose the time required to close the valve should be proportional to the length of the pipe. Air chambers, if placed in the line of the pipe near the valve, will prevent the shock almost entirely, but it is difficult to keep them filled with air. If a safety valve is placed upon the pipe to relieve the pressure it leaves a shock depending upon the strength of the spring.

7. Shock diagrams taken from different points in a pipe enable the position and magnitude of accumulations of air to be determined. The shock diagram may also be used to determine the location of a leak in a pipe, and to obtain general information as to its condition.

Hand Labour and Machine Work.

IN these days of automatic machine tools, and the development of plans on every hand to dispense with the greater part of the skilled labour formerly required in industrial operations, the very elaborate study of the growth of labour-saving machinery, and comparison of the relative value of the two methods of work, by M. E. Levasseur, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* forms an important contribution to industrial literature.

After referring briefly to the early antagonism of hand workmen to labour-saving machinery, and the attempts to destroy such machines as the Jacquard loom, the spinning jenny, and other inventions, M. Levasseur goes on to examine the apparent paradox involved in the idea that labour-saving machinery will enable a better product to be made at a reduced cost and at the same time furnish a greater return of profit to both labourer and capitalist. This he shows is more apparent than real, and arises out of the confusion of the value of the single piece with that of the total output. Machinery enables so much more to be produced in a given time that the pay per piece may be greatly reduced, while the earnings per day are materially augmented.

After various quotations from the report of Hon. Carroll D. Wright, the United States Commissioner of Labour, showing the effect which the introduction of machinery had produced upon the development of wealth in America, comparison is made with similar reports regarding industry in France. Among these the most complete is that of M. Bechmann, the Chief Engineer of the water supply and sewerage of Paris, giving data as to the execution of sewer construction by hand and by use of the shield; also data concerning the influ-

ence of machinery upon other trades, such as glass-polishing, mining, and other branches of work in which improved mechanical appliances have worked a revolution.

In all of these examples it is shown that the introduction of labour-saving machinery has not only made possible a greatly increased productiveness of an improved article at a great economy, but also that these most desirable results have been accompanied with the provision of occupation of an increased number of workers at higher wage rates. The capacity for supplying products at prices which render an extended consumption possible, provides in nearly all cases for constantly increasing markets which it creates, and in all parts of the world prosperity is found accompanying modern facilities, while poverty and degradation are associated with the primitive methods in which the productive capacity of the worker is limited by the crude tools and methods.

M. Levasseur's paper is accompanied with numerous illustrations of labour-saving devices of many kinds, especially those of recent American design, and the whole subject of the economic effects of such devices is discussed in a judicious and intelligent manner.

The Charlottenburg Testing Laboratory.

THE general report of the work of the Royal Testing Laboratory at Charlottenburg, near Berlin, contained in the last issue of the *Mittheilungen*, gives an excellent idea of the varied scope of such an institution, and emphasises the great value which it renders to all branches of technical industry.

As is well known, this important institution is under the able direction of Professor Martens, who is aided by four principal assistants, and a number of subordinates, the total force numbering 74 persons, of whom the greater part are experts and specialists, there being included also the special clerical force for the proper care of records and accounts. The laboratory is equipped with the latest and most improved machinery and apparatus, much of this having been designed by Professor Martens and his associates, and the official character of the institution lends an assurance of reliability to tests there made which cannot be felt with any private laboratory, however high its standing.

The work during the past year showed an increase of about 50 per cent. over that of the preceding year, and it is interesting to note that out of a total of 295 investigations, but 37 were for official purposes, the remaining 258 being for private applicants, the whole involving 4,112 tests of various kinds.

Nearly one-half of these tests were of the tensile strength of various materials, including steel, iron, copper, and various alloys, also of rope, chain, belting, and similar materials; while about one-fifth were compression and buckling tests, not only of metallic substances, but also of concrete, timber, and other building material.

Among the other tests may be mentioned flexure, torsion, and drop tests of metallic subjects, friction tests of bearing materials and of lubricants, trials of the heat-insulating properties of pipe coverings, of the tightness of packings, and of the efficiency of abrasives. Tests have also been made of the strength of steel balls, and the causes and nature of cracks investigated. Some interesting studies of the resistance of steel wire of different degrees of hardness against the action of rust have been made, as well as the extent to which rust diminishes the strength. The influence of annealing and tempering upon steel castings forms a valuable series of investigations, and the tests of rubber hose under the influence of heat and steam pressure gave definite data upon a subject about which little had previously been known.

It would be impracticable to review in this place the extended list of important investigations of the year, but many of them have been reviewed at length in these columns as the reports were made public in the *Mittheilungen*, or *Transactions* of the laboratory. The extent and thoroughness of these reports form no small part of the value of the establishment to the engineering world at large, for while there are many minor tests which are of but little value to others than those directly interested, many of the investigations have their value largely increased by the scientific manner in which they are discussed. In many cases the bare data and results of a

series of tests would be almost useless to the general manufacturer or constructor, while a careful analysis of the figures by a specialist and expert enables conclusions of much practical value to be drawn. The active interest taken by Professor Martens and others of his staff in the work of the international association for testing materials should do much to render the work of the laboratory acceptable to engineers in all countries, since the records there made will doubtless be in conformity to the recommendations of the various sections of the association, and hence strictly comparable with each other and with subsequent tests. It is only by such systematic and organized institutions that definite and permanent progress in a knowledge of the materials of construction can be attained, and the work of the Charlottenburg laboratory will doubtless be a constantly increasing factor in the development of the work of the engineer and constructor.

The Automobile Trolley.

THE greatest obstacles to the use of the electrically propelled motor vehicle for road service has hitherto been the limited capacity of the storage battery, so that recharging is found to be necessary after a run of about 30 miles.

In order to obviate this difficulty the idea has several times been suggested that the current be supplied by an overhead wire, much in the same manner as in the case of the trolley tramway, but in practice a number of difficulties have been encountered with the execution of the idea. Any attempt to provide a trolley pole reaching to the wire above is impracticable, since the vehicle must be able to turn out to avoid passing teams or other carriages, and anything which would deprive the automobile of the flexible control possessed by the independent vehicle would certainly be considered objectionable.

The latest attempt to solve the problem is that of the auto-motor trolley of M. Lombard-Gerin, of which fully illustrated descriptions are given in recent issues of *Le Génie Civil* and *La Revue Technique*. In this device the communication with the overhead wires is made by means of a small motor trolley, riding on the wire itself, and propelled by its own motor, the speed of this motor trolley being automatically regulated by that of the motor on the vehicle.

The arrangement of the device, which is very ingenious, is as follows: Two wires are provided, forming a complete metallic circuit, and through the contact of the two wheels of the trolley the continuous current is delivered by means of a flexible conductor, to the motor on the vehicle. The motor on the vehicle is provided with three rings connected to the winding at the proper points and provided with collectors, so that a three-phase current is delivered through conductors forming a part of the flexible cable, to a small squirrel-cage motor mounted in the trolley. The revolutions of this motor propel the trolley along on the conducting wires upon which it is carried, and, as the speed of its motor is controlled by the speed of the motor on the vehicle, it keeps pace with the main vehicle without requiring any attention whatever. In order that the trolley shall always keep ahead of the vehicle, it is arranged to have a slightly greater speed of travel than the carriage, the difference causing a small amount of slip, keeping the flexible cable well stretched out ahead. An electromagnetic brake, operated from the vehicle, enables the trolley to be stopped positively when necessary.

The device has been given a number of trials on an experimental section of roadway of 900 metres in length along the left bank of the Seine, and, from the photographs which have been reproduced, the vehicle appears to have been well under control, turning out for heavy teams or opposing vehicles as readily as if its motive power were self-contained.

The applications of such a system are numerous, and well worthy of consideration. Apart from affording opportunity for continuous road travel for electrical vehicles, it permits the extension of the radius of suburban trolley lines, automobile feeder lines radiating out from the terminal stations of such lines, and bringing passengers to whom the road would otherwise not be accessible. Current for such purposes could be furnished by the local electric-lighting stations, thus furnishing an increasing daylight load for such installations. In mountainous countries,

such a highway trolley system might be installed to great advantage, especially as the current could in nearly all instances be furnished by the utilisation of local water powers, and the laborious hauling of loads by animal power be avoided.

It is proposed to make all the automotor trolleys interchangeable, so that vehicles going in opposite directions may pass each other by exchange of connections, and the details of the apparatus, as illustrated in the articles referred to, appear to have been well worked out in every respect. The system thus stands midway between the electric tramway and the independent automobile, and will probably fill a function now not practicable for either.

The Development of Madagascar.

THE work of the engineer constitutes an important portion of the military strength by which savage countries are conquered by civilised nations, and when such conquests are achieved it is by the work of the engineer that the benefits of civilisation are introduced and perpetuated.

Since the acquisition of Madagascar by France a number of plans have been made for the exploitation and improvement of the country, and the character and progress of these works form the subject of an article by M. A. Dumas in a recent issue of *Le Génie Civil.*

Before the French occupation, the island of Madagascar was almost without improvements of an engineering character, the native roads being little more than rude paths, while the few harbours were practically natural anchorages without artificial improvement. Since the country has been pacified, however, numerous evidences of improvement have appeared, notably in regard to means of communication, and some account of these is appropriate here.

The island of Madagascar, which is 1,030 miles long and 360 miles wide, possesses three distinct varieties of territory. The first, the sea coast, has a very warm climate and a fertile soil, and in spite of the few good harbours access is readily had to nearly all parts by water. The second portion is the intermediate region, lying between the coast and the higher central plateau, and consists of a broken and irregular country, the ascent to the plateau being traversed by numerous rivers, and capable of sustaining but a limited population. The central part of the island forms, in part, an extended plateau, and in part a mountainous country, the elevation varying from 4,000 to 5,000 feet above the level of the sea. This is the most desirable part of the entire country, and is well populated, being occupied by the two principal tribes, the Hovas, whose capital is Tananarive, and the Betsileos, whose principal city is Fianarantsoa.

The main undertaking of the French engineers at the present time is to effect satisfactory communication between the sea coast and the plateau, and especially to construct a railway between the harbour of Tamatave, on the east coast, with the capital of Tananarive. There had existed for a long time a native foot path from the harbour of Andevorante, about 60 miles south of Tamatave, to the city of Tananarive, as well as a path along the coast from Tamatave to Andevorante, but these were only available for foot travelers, and the road to Tananarive contained some very steep and difficult grades. During the war military supplies were sent by a road from Majunga, on the west coast, using the navigable waters of the river Betsiboka for a portion of the way, and being carried by native porters for the balance, and although this road contains some very steep grades it is now being improved and will be converted into a wagon road hereafter.

Several attempts were made to finance a railway from Tamatave to Tananarive by offering land concessions to private companies in return for the assumption of the construction works and operating privileges, but these having fallen through, the work has been undertaken directly by the colony, a loan of 60 million francs having been negotiated, not only for railway construction, but also for highways, telegraphs, and harbour improvements.

Several routes have been surveyed for the railway from Tamatave to Tananarive, the most favourable being that advocated by Colonel Roques, the plan and profile of which are given on a map accompanying the article referred to. It is an interesting fact that this plan includes the proposition to employ rack railways on the steeper grades, using electric traction, the current

being generated by the utilisation of the numerous rapid streams flowing from the table land to the sea coast. The cost of the road is estimated at about 47,500,000 francs, and 27,000,000 francs have already been appropriated for the immediate construction of the section between Tananarive and Anivero. The total length of the railway, according to the survey of Colonel Roques, is about 247 miles, the plan being necessarily very circuitous.

Another important enterprise in Madagascar is the opening of a landlocked water-way along the coast, between the harbours of Tamatave and Andevorante. The eastern coast of the island contains many lagoons and bays, practically landlocked, and giving opportunity, by cutting a few barriers, to provide a continuous and unimpeded water-way between the two harbours. The cutting of the "pangalanes," as the barriers between the lagoons are called, was begun at the close of 1897, and more than one-half of the work will be completed before the close of the present year. A short line of railway is already built from Tamatave to Ivandra, where the practicable water-way begins, and the completion of this work will place both harbours in commercial communication with the capital as soon as the main railway is finished.

There appears to be little doubt that the energetic manner in which the various projects for the exploitation of the island are being pushed will result in a rapid development of the native products of Madagascar, and there appears to be every reason to believe that the colony will assume a position of great commercial importance in a few years.

Large Gas Engines.

One of the most convincing evidences of the progress which is being made in the use of gas as a motive power is the increasing attention which is being paid to the design of large gas engines, that is, of engines ranging from 100 to 600 horse-power and over, as compared with the former range of capacity of 5 to 50 horse power.

A general review of the development of the large gas engine, showing the lines along which progress has taken place, is contained in a paper by Professor E. Meyer, published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, from which the following abstract is taken.

The possibility of extending the scope of the gas engine to large powers was seen after the applicability of lean, or producer gas, as a fuel for internal-combustion was demonstrated, and with the extension of this idea to the utilisation of blast-furnace gases it became evident that the field for the large gas engine was open.

Among the early gas engines of more than 100 horse-power may be noted the engine for the pumping station at Basle, this being of 160 h.p., erected in 1894, an account of its test being given in these columns in the issue for February, 1897. This was followed by still larger engines, especially those intended for use with blast-furnace gases, and now engines ranging as large as 600, 1,000, and even 1,200 h.p. have been constructed.

Since the Beau de Rochas cycle, generally used on internal combustion motors, gives but one power stroke in every four, such engines are necessarily larger than steam engines of the same power, notwithstanding the fact that the mean effective pressure is higher. The high pressures demand increased dimensions in the connecting rods and shaft, this latter detail being also affected by the fact that the irregularity of impulse requires the use of a very heavy fly wheel. The high temperatures introduce further mechanical problems, involving the introduction and circulation of cooling water, while the question of ignition has been a troublesome one from the first. All these details become increasingly difficult to handle in engines of large size, and it is only recently that they have been practically surmounted.

Professor Meyer gives an illustration of the Körting gas engine as a typical design for a single-cylinder motor, suitable for capacities of 120 h.p. and under, but for larger engines it is desirable that more than one cylinder be used, not only to avoid the use of inconveniently large diameters, but also to enable the impulses to be delivered more frequently, permitting the use of relatively lighter fly wheels, and a better distribution of working stresses. Several arrangements of multiple cylinders are possible, and of the more general forms sche-

matic diagrams are given. One form employs two cylinders placed side by side, the two cranks being at an angle of 360°, that is, in line with each other, the fly wheel being between. When one cylinder is making its power stroke the other is drawing in its charge, and when one is compressing the other is exhausting, power strokes thus being made by each cylinder alternately. In another design the two cylinders face each other, being on the same axis, both connecting rods being coupled to the same crank, the crank shaft lying between the two cylinders. This places the cranks virtually at an angle of 180° with each other, the charging stroke of one cylinder coinciding with the compression stroke of the other. For large engines this latter arrangement is sometimes doubled, there being four cylinders, and consequently one power stroke regularly succeeding another, or two to each revolution. The third arrangement has the two cylinders placed tandem, the pistons being upon one common rod, this design requiring but one connecting-rod and crank. The principal objection to this plan is that it involves the use of a stuffing box between the two cylinders, which is not such a simple matter as with the steam engine, owing to the high temperatures existing. Such engines have been successfully made, however, by Körting, the piston rod being made hollow, and cooled by a circulation of water through it. This construction, however, is more expensive than the double-cylinder engine with side by side cylinders.

The largest single-cylinder engines which have been put into practical operation until now are those made by the firm of Cockerill at Seraing, for the purpose of utilising the gases of blast furnaces for driving blowing engines. Four of the engines have been erected at the iron works at Differdingen, each being of 500 h.p., with cylinders of 51.18 inches bore (1,300 mm.), and 55.12 inches stroke (1,400 mm.), making 80 to 90 revolutions per minute. In these engines the piston rod is prolonged through the cylinder head and connected directly to the piston of the blowing cylinder.

A new form of double cylinder gas engine, adapted for large powers, is that of Oechselhäuser, constructed by the Berlin-Anhalt Maschinenbau Aktien Gesellschaft. In this engine the two cylinders are open at both ends and are bolted together end to end, forming practically one cylinder of double length. The two pistons move in opposite directions, the one nearest the shaft being connected to a centre crank, and the other connected by return rods to two return cranks. An air pump is operated by a prolongation of the rear piston rod. There are neither exhaust nor charging strokes, the burned gases being expelled during the last eighth of the stroke by the entrance of compressed air from the blowing engine, a side port near the end of the stroke being provided for the purpose. The compressed charge is delivered into the cylinders during the first eighth of the return stroke, after which compression takes place, so that every out-stroke is a power stroke. Indicator diagrams show an excellent action, and tests show a consumption of 3.5 cubic metres of furnace gas of a calorific power of 900 to 1,000 calories per cubic metre, per horse-power-hour, an efficiency of 18 to 19 per cent. Fuel economy, however, is a matter of minor importance when the combustible is a by-product, as is the case with blast furnace gases.

In using furnace gases in motors it is most desirable to secure the proper mixture of air and gas, and it is found that the proportion of air to gas bears an important relation to the degree of compression. For moderate or low compression it is better to have a larger proportion of air in the mixture, while with higher compressions less air is required.

Professor Meyer discusses many details of gas engine design, especially with regard to large motors using lean gas, and his paper should be consulted by all who desire to realise the conditions under which the gas engine is competing with steam.

The Splugen Tunnel.

THE demand for increased railway communication between Switzerland and Italy seems to warrant the development of improved routes, and no sooner is one enterprise for piercing the Alps fairly started than another is agitated. The Mont Cenis was followed by the St. Gotthard and the Arlberg, while the Simplon is now being actively pushed, and this will probably be followed by a tunnel at the Splügen Pass,

the preliminary schemes for which are given in a recent issue of the *Schweizerische Bauzeitung*.

The idea of a connection between eastern Switzerland and Italy is not new, having been discussed as long ago as 1886, when preliminary surveys were made under the joint auspices of the Splügenkomitee on behalf of Switzerland, and the Società Adriatica on the part of Italy. The plans included a railway from Chur, in Switzerland, to Chiavenna, in Italy, to which points railway connections already existed, the length of new railway thus required being about 61 miles.

The estimated cost of the road, according to the plans of the Italian engineers, was 146,600,000 francs, and the magnitude of the amount led to a postponement of the scheme until a further inspection of the various possible routes might make it sure that the most economical plan had been chosen. The matter was therefore referred to the well-known Swiss engineer, Herr R. Moser, by whom the article referred to was written, the object being to select a route which should conform to the following conditions:

1. The highest elevation of the road must not be more than 1,200 metres above the sea.

2. The maximum grade on any open part of the road must not exceed 2.6 per cent., and in tunnels of more than 600 metres in length it must not exceed 2.3 per cent.

3. No curves may be of less than 300 metres radius.

4. The grades in the main tunnel must not exceed 0.6 per cent.

5. The road is to be planned for single track, except for the portions between the stations nearest the tunnel and the tunnel portals, and in the tunnel itself, where the road is to be double track.

6. The line of the road in the Bergell valley is to lie as near to the Swiss frontier as possible.

Herr Moser proceeds to examine the Italian route, giving plans and profiles, and shows that by a modification the cost may be materially reduced. Both plans involve the construction of a main tunnel, 18,640 metres (11.57 miles) long, in the Italian plan, and 18,180 metres (11.29 miles), in the Moser plan. In the approaches, however, Herr Moser has succeeded in modifying the plans so as to permit of a material reduction in the estimated cost, and in the topographical maps accompanying his paper he shows the comparative routes of the two schemes very clearly. From these it appears that the new plan for the Splügen railway and tunnel offer no difficulties greater than those successfully overcome in the St. Gotthard railway, the cost of the tunnel being somewhat greater only because of the greater length.

Herr Moser's estimate for the cost of the revised route is a total of 112,554,000 francs, a saving of more than 34,000,000 francs over the Italian route, this gain being accomplished by shortening the length of the railway by about 5 kilometres, and by reducing very materially the lengths of the shorter tunnels in the approaches.

Since the proposed Splügen route would form a portion of the same system as the Brenner and the St. Gotthard routes, it is desirable to show to what extent it could expect to share the traffic. Taking Zürich and Bale as the commercial terminals in Switzerland, and Milan in Italy, it appears that there is but little difference so far as distances go, but that there is a very material advantage in favour of the Splügen route as regards grades and elevation to be overcome, this latter amounting to more than 800 metres in favour of Splügen.

The volume of traffic to be looked for by the opening of this proposed railway cannot be deduced from Swiss sources, since the greater part of it would have to come from other countries, Switzerland profiting thus by its position as the most available highway. Whether the possible returns to be expected from this business would be sufficient to make the construction of a work of such magnitude profitable remains to be seen, but it is not improbable that before the Simplon tunnel is wholly completed, its successor at the Splügen Pass will have been commenced.

REVIEW OF THE AMERICAN PRESS

The Flow of Water in Rivers.

REFERENCE was made in these columns, in the April issue, to the recent measurements of the flow of the Niagara river in connection with the paper of Mr. Clinton W. Stewart, presented before the Western Society of Engineers. The discussion of this paper brought out some interesting features in connection with the important question of river gauging, and from the *Journal* of the society some of these points are here reviewed.

Professor J. B. Johnson showed that the velocity curves given in Mr. Stewart's paper, if carefully studied, threw light on the causes of retardation of the flow of water in channels, and called attention to the fact that the high value of the coefficient of roughness, so-called, deduced for the Kutter formula from these gaugings, indicated the small influence which the wetted perimeter exerted upon the flow, either in width, length, or character of surface. There seems to be little doubt that the great resistance to the flow of water is not the direct frictional resistance of the water against the banks and bottom of the bed. It is really due almost altogether to the resistance to internal motion, or what might be called the internal work of the water. Much of this internal work is due to the roughness of the channel, but it is an indirect influence which is thus exerted, and it is the churning up of the water that uses up the hydraulic head, and not the direct frictional resistance of the wetted perimeter.

The bottom of the Niagara river is very irregular, full of rocks and irregularities, so that the water is in a continual boil, and a similar action takes place even in rivers flowing over alluvial bottom, such as the Mississippi. These streams provide their own extraordinary resistance, moving the sand into ridges on the bottom, called sand waves, and the water becomes filled with boils and eddies as it passes over these inequalities, and thus much of the head is lost.

A notable instance of the marked influence which this internal work may exert upon flow is seen in a well-known case of a four-foot steel conduit in which a marked error in the computed flow occurred because sufficient account was not taken of the internal motion caused by the rivet heads and the lapping of the plates. It is by no means enough to assume that the area is diminished by the deduction of an annular ring included by a circle taken inside of the rivet heads, since the eddies and swirls formed in the water by the projections absorb much more of the head than corresponds to such a reduced section. Engineers should keep their minds centered on the fact that the loss of head is mainly due to the internal work of the water, and that anything which adds to this internal work deducts very greatly from the available head.

It is this vortex motion of the water which makes it difficult to obtain reliable results with current meters, since there is not a uniform velocity at any point in the section, but a mixture of continually varying velocities, the average of which it is sought to obtain. This point was well brought out in the discussion by Mr. J. A. Seddon, who said: "There is no such thing as continuous lineral motion of water in rivers. Every actual slope line is a line of uniform acceleration which runs into a whirl, and that is the end of it. With the known viscosity of water, there is no other way in which a resistance can be developed that will balance the motion, and it does that in the flow simply by holding it between oscillating extremes, like the balance wheel of a watch or a regulating pendulum. In the flow, then, practically all the energy of the discharge and fall simply passes into vortex motions, just as it does in the drop over Niagara, only in the river this action is in general distributed and intermittent."

The meter, therefore, has not only to face the general drift in the direction of the flow, but has also a stream of whirls

and eddies thrashing through it. Since current meters are generally calibrated or rated in still water, or at least in a continuous and uniform current, it would seem as if the changed conditions existing in a rapidly running stream might account for many of the discrepancies which are found to occur. It is advisable to use more than one method, wherever possible, in order that any serious error may be revealed by the discrepancy. The rod float is perhaps as liable to error as a meter, but if measurements by both methods agree fairly well there is a confidence felt in the result which must be greater than that due to the same substantial agreement of two meters.

When the important consequences which depend upon reliable measurements of flow of water are considered, there is every reason to encourage such discussions as that which Mr. Stewart's paper elicited and to give them such publicity as the importance of the questions warrant.

The Power Consumption of Automobiles.

LAST year a paper was presented before the American Institute of Electrical Engineers by Messrs. Sever and Fliess upon the comparative cost of operating delivery wagons in cities by electricity, as compared with horses. This paper was reviewed in these columns in the issue of September, 1899, and now we have an account of the continuance of the investigations upon which the conclusions were based, in the form of a paper by Professor George F. Sever, in a recent issue of the *Electrical Review*.

Up to the time of the presentation of the first-mentioned paper there had been little information of an authoritative nature available upon the coat of either horse or electric service, and hence it was necessary to determine the cost of horse operation in order to procure the basis for comparison. Later experience had confirmed the practical accuracy of the figures obtained by the first investigation, which are substantially as follows:

"Total cost of 1 wagon, 1 horse, wages and attendance per day, equals 364.83 cents, of which 64.61 cents, or 17.7 per cent., is chargeable to the horse, 14.52 cents, or 3.98 per cent., is chargeable to the wagon, and 285.7 cents, or 78.32 per cent., is required for the wages of the driver and his helper.

"The total weight to be moved is 2,075 pounds, or approximately one ton, 500 pounds of this being considered the weight of the load to be delivered. In this service each wagon covers 21 miles per day, so that the cost per ton-mile, which is the unit of comparison, would be 364.83 : 21, or 17.373 cents."

Similar computations for a two-horse wagon, intended to cover twice the distance, give a cost of 10.2 cents per ton-mile. Having these data for the horse-drawn wagons, comparison may be made with the electric vehicles. Tests made in New York of a large variety of vehicles of different kinds on various pavements, gave an averager of 120 watt-hours per ton-mile, or 0.156 horse-power hours per ton-mile, as the expenditure of electrical energy, in such service. Of course it is necessary to provide a larger capacity than this, both for starting, and to meet the demands of heavy grades, while the minimum power shown in any of the tests was 81 watt-hours per ton-mile.

Taking the speed of the electric vehicle at 9 miles per hour, the 42 miles would be covered in 4.66 hours, and if the cost per kilowatt hour be taken at 5 cents, the cost for power would be 71.28 cents, the power consumption being 120 watt-hours per ton-mile. Taking in the charges for interest on wagon, stable rent, and wages, the total cost for operating comes out 404.26 cents, there being thus a saving of 24.28 cents per day under these conditions.

An important point in this connection is the greater weight of the electric vehicle, the total weight for a load capacity of 500 pounds being 2.263 tons. It is, of course, important that every effort should be made to reduce the weight of the wagon, in order to increase the ratio of load delivered to the total weight, and thus reduce the total power cost.

A fairer manner of comparing the power costs is to eliminate in both cases the fixed wages for driver and helper, when it is found that the cost of the horse forms 90 per cent. of the operating costs in that service, while the cost of power in the electric service is only 60 per cent. The actual saving is naturally the same, *i. e.*, 24.28 cents per day, but this is a saving of 17 per cent. over horse operation.

It is not practicable to fix any reliable figures for depreciation, since the apparatus is too new to afford data as to its life.

The depreciation should not be large, so far as the motors and running parts are concerned, but a depreciation factor of 20 per cent. should be allowed for the battery.

"That the differences shown are not larger is due to the fact that in making the comparisons, the lowest average cost for horse service has been taken and the highest cost for electric service has been placed against this. With cheaper power a further reduction can readily be made in the operative costs and a better showing made for the electric service. It can be pointed out that if the schedule speed of the automobiles can be raised, the wagons can cover much more territory per day, and therefore reduce the percentage that the employees' wages are of the total. This is a similar condition to that which exists in electric railway operation, and many of the same operative details that now control railway work can be successfully applied to electric delivery service."

When the experience which has been gained in the practical operation of electric street railways is considered, there is every reason to believe that many economies may be anticipated in the use of electric vehicles for delivery service, while the horse service has doubtless reached its best long ago.

The Action of Water on Asphalt.

ALTHOUGH asphalt is mainly used for the construction of pavements, it is coming into use for various other purposes, and of late it has been employed in many places for lining the reservoirs of water works. For several reasons it is well adapted for this purpose, as by its use a smooth, clean lining may be obtained at a moderate cost, and almost perfect tightness against leakage, and in fact, reservoirs which have given much trouble from leakage have been made satisfactorily tight by giving them asphalt linings.

It has naturally been assumed that the asphalt was unaffected by contact with the water, but in a paper recently presented before the Engineers' Club of Brooklyn by George C. Whipple and Daniel D. Jackson, and published in *Engineering News*, the results of a number of experiments are given, which in some cases seem to prove the contrary. These tests were conducted at the Mount Prospect Laboratory of the Brooklyn water works, and covered a period of about two years, so that there is every reason to believe that the conditions in actual practice were repeated. In the case of pavements the asphalt is intermittently subject to the action of water during rains and washings, and in winter it may be for a long time in contact with snow and ice. In the case of reservoir linings the asphalt is alternately wet and dry at and near the water line, and is also exposed to the erosive action of the waves and force of the ice in winter. Below the water line it is in continual contact with the water, and at the bottom of the reservoir the added action of pressure due the weight of the water must be considered.

Seventeen specimens of asphalt were investigated, these including the varieties generally used for paving, but not including the rock asphalts. The experiments were conducted along three lines: First, that of placing samples of the asphalts in contact with water in glass jars and subsequently noting the change in the analysis of the water, thereby ascertaining the nature of the soluble constituents of the asphalts. Second, that of immersing samples of the asphalts in water under various conditions and noting their change in weight. Third, that of observing the action of water upon the asphalts by noting changes in their physical condition. Both distilled and surface waters were used, so that any difference in action might be observed, if such existed.

The investigations revealed a wide difference in the behavior of the different varieties, and the results should have much influence upon the selection of asphalt for reservoir linings. In some cases there was a change in color from black to brown, the asphalt being converted into a soft, punky material, covered with cracks and pits, this action appearing in the Trinidad asphalt, and to a lesser degree and more slowly in the Bermudez asphalt. In the various grades of Alcatraz asphalt a similar action took place, varying in extent, however, and being but slight in some cases. In the hard Cuban asphalt there was practically no change, while in the Assyrian asphalt, but

one grade, No. 5, showed any material action. The details of these actions are fully given in table annexed to the paper, which should be consulted for reference. Tables are also given showing the loss after a period of two years' immersion, together with the results of the analyses of the waters in which they were immersed.

The cause of the action of water upon asphalt appears to be in part chemical and in part physical, and according to Richardson, the molecular structure of the asphalts is an important consideration. A certain amount of water is absorbed physically, as shown by an increase in weight, and the brown punky material will lose weight on drying. Throughout the course of the investigations it was observed that the waters which contained the smallest amount of mineral matter produced the greatest action upon the asphalts. Sea water gave but little action, while the most marked effect was produced by distilled water. A determination of the amount of dissolved oxygen in the distilled water, sea water, and brine gave the following results in cubic centimeters of dissolved oxygen per liter: Distilled water, 7.1; sea water, 4.8; brine, 0.6.

These facts show conclusively that the action of water upon asphalt is largely one of oxidation and is due to the oxygen dissolved in the water. As a final test, however, a sample of Trinidad asphalt was covered with water which had been boiled until free from oxygen, and then tightly sealed to prevent absorption from the air. The action that took place under these conditions was very slight. It appears, therefore, that water acts chiefly as a carrier of oxygen and does not to any extent give up the oxygen of its own composition.

A practical example of the behavior of asphalt in actual service as a reservoir lining is given in the case of the reservoirs at Denver, Col., one of which was lined with Trinidad asphalt and one with California asphalt in 1891-1892, both of which have become very unsatisfactory in condition by cause of the action of the water.

A Water-Distilling Plant.

THE experience with the use of salt water in the boilers of naval vessels during the Spanish-American war has led the government to provide increased facilities for the supply of pure distilled water to vessels at various points, as well as the construction of distilling ships to accompany naval squadrons on cruises.

A very interesting account of the test of the new distilling plant recently erected at Dry Tortugas, off the coast of Florida, is given in a paper by Lieutenant R. K. Crank, U. S. N., in a recent issue of the *Journal of the American Society of Naval Engineers*, from which some abstracts are here made.

The apparatus used at this station is constructed upon the same principle as that employed in the manufacture of sugar, and in fact the evaporators are "triple-effect" sugar evaporators applied to the distillation of water without material change in construction or operation.

"The method followed in this 'multiple-effect' system is, briefly, as follows: The sea water to be evaporated is first passed through heaters which are supplied with steam from the boilers or from the pressure-reducing tank. The temperature of the sea water is raised to about 300 degrees or more in the heaters. The heated sea water then passes to a pressure-reducing tank, in which a pressure of from 10 to 15 pounds is maintained. A portion of the water becomes steam on account of the low pressure and high temperature. The exhaust steam from all the auxiliary machinery of the plant also goes into this tank. The steam from the pressure-reducing tank is almost all employed to heat the first heater through which the sea water is passed. The unevaporated portion of the sea water in the tank then goes into the first effect (or evaporator), passing first through a centrifugal circulating pump, by which it is showered over the outside of the evaporating tubes. Live steam from the boilers, supplemented by steam from the pressure-reducing tank, is admitted to the inside of the evaporating tubes. A portion of the sea water is converted into steam; this steam passes into the evaporating tubes of the next lower effect, where it aids in evaporating the salt water in that effect. The unevaporated portion of the sea water falls to the bottom of the first effect, whence it is drawn by the centrifugal pump and again showered over the evaporating

tubes of this effect, the loss from evaporating being automatically supplied, through a float valve, by fresh feed from the pressure-reducing tank. This action is continued in each of the effects, the constantly moving sea water increasing in density as it passes in turn through the effects. In the last effect, the brine is drawn off at any desired density at a temperature corresponding to the very low pressure (below atmospheric pressure) maintained in this effect. In an ordinary 'single-effect' evaporator, such as is used aboard ship, the brine is blown off at a comparatively high temperature and much heat is wasted."

It will be seen from the above description that every effort is made to utilize the heat to the best effect, and as a consequence a very efficient performance should result, and it was to ascertain the effective performance that the test was made.

The plant was installed to produce 60,000 U. S. gallons of distilled water every 24 hours from sea water, for six days of each week, allowing one day out of each week for cleaning. The test was therefore made of six days' duration, rendering both the capacity and economy to be determined.

The data and results of the test are tabulated very fully in the paper, to which reference must be made for details, as well as for illustrations of the various points of construction.

The total amount of water distilled in the six days was 548,418 gallons, of which 193,856 gallons were used to feed the boilers, giving a net output of 59,260 gallons per day, or practically the amount required, and the economy of the apparatus was such that 21.58 pounds of water were distilled per pound of coal for the gross output, or deducting for the water supplied to the boilers, each pound of coal produced 13.98 pounds net of pure water.

In order to show the high degree of efficency which is thus attained, Lieutenant Crank gives a computation showing the theoretical maximum evaporation possible by this sysytem to be 23.6 pounds of fresh water per pound of coal, while as above stated, the actual output of the plant at Dry Tortugas was more than 21½ pounds, a most satisfactory result.

An interesting feature of the apparatus is the method proposed for cleaning. After the six days' run it was found that there was only a light scale on the tubes of the heaters, varying from 1-64 in the first to 3-64 in the third. The tubes of the first and second effects were practically clean. In the third effect the incrustation was 5-16 thick. This scale is removed by running a solution of carbonate of soda through the heaters and effects, which acts on the insoluble scale, forming soluble sulphate of soda and carbonate of lime. A dilute solution of hydrochloric acid is then run through, acting upon the remaining carbonate of lime, and completing the cleaning process, this operation being performed every seventh day. Since no portion of the heating surface is exposed to intense heat there is no baking of scale, and it is believed that this method of cleaning will prove effective, although it will require time for its action to be demonstrated.

The Performance of Slow Sand Filters.

SEVERAL months ago the account of the large filtration plant installed at Albany, N. Y., was described in these columns, in connection with the paper presented before the American Society of Civil Engineers by its designer, Mr. Allen Hazen, and now we have as a part of the discussion upon that paper some valuable data in regard to the performance of this, the largest slow sand filtration plant in the United States.

The most important fact, next to those relating to the bacteria efficiency of the filters, are those relating to the cost of filtering the water, and from the discussion of Mr. George I. Bailey, the superintendent of the water works, some definite costs are obtained.

The general figures are given, from which a summary is made, showing that for a period of 118 days the cost of operation of the works was $6,614.94, during which time 1,470,000,0000 gallons were pumped and filtered, making a cost of $4.19 per million gallons. The cost of pumping alone is given as $2.52 per million gallons, leaving $1.67 as the cost of operating the filters, including laboratory work. The cost of scraping, wheeling out, washing and replacing sand, for the actual number of hours, exclusive of superintendence, laboratory work, lost time, tools, etc., is $1.19 per million gallons treated.

So far as bacterial efficiency is concerned, the filter has given excellent results. The weekly averages of the bacteria in the unfiltered water ranged from 4,733 to 66,000 per cubic centimeter, and the percentage of removal ranged from 94.8 to 99.7; the former figure was exceptionally low, the next lowest being 97.8.

The brief period during which the Albany filters have been in operation is not sufficient to show exactly the degree to which the purification of the Hudson River water will ultimately attain, but the results already obtained are excellent and should show improvement hereafter.

While slow sand filtration can be depended upon to remove nearly all pathogenic bacteria, it will not remove all coloring matter from the water. This is not a matter which the experts consider serious, but the ordinary consumer cannot understand why the filtered water should not be colorless. Experiments have shown that simple sand filtration is not capable of removing more than about one-half of the coloring matter from water, under favorable conditions, and that ordinarily the amount of reduction is not more than one-third or one-fourth.

Odors are also difficult to remove. It has been found at Albany that sand filtration is not always effective in removing certain odors from the water. The odor imparted to the water by the waste material discharged from the gas works, and which is not removed by the filters, has caused complaint from the consumers. This is undoubtedly an objection, and since it has been shown that filtration will not remove it, some precautions should be taken to prevent such discharges from getting into the stream, and since the source can readily be determined, there should be no difficulty in applying preventive measures. The progress which has been made in the application of methods for the purification of sewage and factory refuse has been such during the past decade that there is now little or no reason why all distinctly injurious matter of which the origin may be traced, should not be treated before it is permitted to be discharged into any stream which is subsequently used for water supply.

The Albany filters are covered, but the reservoir for the storage of the filtered water is open, and it is a matter of interest to biologists to observe the extent to which the water will be affected by the appearance of algæ growths. It has generally been observed that ground waters, when exposed to light, are liable to deterioration from this cause, but the reservoir at Albany has hardly been in use long enough to determine whether or not any serious inconvenience will result from this cause.

Altogether the general results which have been obtained thus far from the operation of the Albany filters, the largest which have as yet been put into operation in the United States, are decidedly encouraging effective method of purification used to securing a pure water supply is concerned. Many great cities have definitely come to the conclusion that an original pure water supply cannot be secured or maintained, and the general opinion is that such supply as is available must be secured, and some effective method of purification used to secure a satisfactory quality. In view of this conclusion the experience of Albany is most important and instructive, and should lead to many similar installations in places where there has until now been hesitation and doubt.

The Verification of Electrical Standards.

A STANDARD of measurement is of little value unless some authoritative method of verification which shall be acceptable to all users is provided, and in fact, without some such source of verification it soon ceases to become a standard. In Germany the Imperial Physico-Technical Reichsaustalt is accepted at the ultimate bureau of verification, while in England the standards of the British Association are accepted, and in the United States the Bureau of Weights and Measures is endeavoring to do what is necessary within the range of its many limitations.

An article in a recent issue of the *Electrical World and Engineer* by Dr. Frank A. Wolff, Jr., discusses the facilities afforded by the Office of Standard Weights and Measures for the verification of electrical standards and electrical measuring apparatus in the United States, and in connection with this subject he gives some

account of the history of the units of reference employed.

At first all standards of quantity and value were arbitrary and crude, but Gauss and Weber solved the general problem by defining all units in the terms of the mechanical actions to which they give rise. Since all mechanical units can be expressed in terms of three independent fundamental units, such as those of length, mass, and time, the magnetic and electrical units of Gauss and Weber are thus expressible in terms of the same fundamental units, and are therefore entirely independent of the physical properties of arbitrarily chosen substances. Hence they are called absolute units, their magnitudes depending wholly on the choice of the fundamental units.

The units of length and mass selected were usually multiples or submultiples of the corresponding metric units, the centimeter, gramme, and second having now been universally adopted, the derived units being known as the C. G. S. units.

Dr. Wolff proceeds to describe some of the arbitrary standards of electrical resistance, such as that of Jacobi, consisting of the resistance of a certain piece of wire, of which a number of copies were made; this was followed by the standard of Dr. Werner Siemens, which was the resistance, at 0° C., of a column of mercury, 1 square millimeter in cross section, and 1 meter in length. He then goes on to show that while the C. G. S. system is theoretically the true one, yet in actual practice it has many inconveniences, and while it should be used in laboratories of reference and verification, it may be replaced by the resistance of a definite portion of a definite substance. The principal difficulty in this respect is that of securing uniformity in chemical and physical character of the material, the resistance being affected very materially by slight differences in these respects.

Various attempts were made to secure a standard of some concrete nature, and from the time of the first international electrical congress in Paris in 1881 down to the meeting at the World's Fair in Chicago, in 1893, the subject was under discussion and revision.

At the latter time it was officially decided to adopt as the unit of resistance the mean of all the best determinations, the resistance at 0° C. of a column of mercury 106.3 centimeters in length, and having a mass of 14.4521 grammes. The unit of resistance and the other electrical units defined by the international congress were legalized in the United States by act of Congress in 1894, and have also been legalized in the other countries represented.

The apparatus used in making comparisons and determining the errors of standards is described very fully by Dr. Wolff, as well as the method of operation. An example of the work is given by a detailed comparison, showing the closeness with which a number of independent measurements agree.

The unit of electromotive force, the volt, was legally defined to be $\frac{1000}{1434}$ of the electromotive force of a Clark standard cell at 15° C. Since the standard cells which have been made for purposes of comparison agree within plus or minus .005 per cent. it will be seen that this is very satisfactory.

According to Ohm's law the standard of electrical current should be determinable from the ratio of the electromotive force to the resistance, and the international congress made a grave mistake in attempting to define three units when the third could be derived from the previous two. Instead of deducing the standard of current from the electromotive force and the resistance, it was defined by the electrochemical equivalent of silver. Current may, however, be consistently measured by the fall in potential in terms of specified standards of resistance.

While the Office of Weights and Measures is prepared to make comparisons of all these standards within moderate limits, its facilities need widening in view of the great extension of the practical applications of electricity. The facilities are inadequate for the measurement of such quantities as potential differences up to 20,000 volts, and currents of 20,000 amperes, and yet such magnitudes are met with to-day in actual practice. Facilities are also required for the verification of alternating current apparatus, and for photometry, as well as the measurement of high and low temperatures, and with the increasing importance of all these determinations in the arts it is

to be hoped that this necessary portion of government work will receive the means and support which its industrial value demands.

Sewer Ventilation.

In a valuable paper upon the subject of sewers by Mr. A. Prescott Folwell in a recent issue of the *Engineering Record* some interesting points are brought out.

"The average citizen thinks of sewer air as something which is invariably connected with the public sewers only; and if there is a good main trap in the house connection, and a few manholes with perforated covers are placed along the line of the sewer, no further thought is given to the sewer air."

Although this view does not apply to engineers who have given sanitation attention, yet there is a difference of opinion among experts as to the proper method of ventilation, and hence a comparison is made of the practice in various cities.

An examination of the sources of air pollution shows that the most favorable conditions for its production are in the soil pipes and house connections, so that trapping these off from the main sewer will not prevent the poisoned air from entering the building. The aim should therefore be not only to exclude from buildings the sewer air but also the air from their own piping. Attempts have been made to use forced ventilation, but with the exception of the Liernur system, in which the outlets are tightly sealed, these have not been successful.

"With sewers and house connections as now constructed, the only practicable plan seems to be that of providing the greatest freedom of air circulation in both sewer and connected pipes. Open channels for these would afford the freest ventilation, but this construction is objectionable for several reasons, and the nearest approach possible seems to be to provide the maximum number of connections between the sewer and the outer air. One means to this end is the construction of numerous manholes with perforated covers. If the street-water enters the sewer, the inlets can also be used for this purpose if no traps be placed in the pipes connecting them with the sewer. Sewers carrying house-sewage can be ventilated through the house soil-pipes if the running or main traps be omitted, or through pipes leading from below the main traps and extending above the roofs of the buildings. If a sufficient number of these and other outlets are provided, continuous circulation of air is caused by difference of temperature between the sewer air and that outside, by wind blowing by or into the openings, by fluctuations in the volume of the sewage, which increases or decreases the total air space in the sewers, by the friction of the flowing sewage upon the air, and by other minor causes. Special inlet or outlet pipes placed along the curb or elsewhere are seldom other than beneficial, but cannot be relied on to act always as either inlet or outlet alone, and are probably not more beneficial than untrapped soil pipes of the same size; and if it can be shown that untrapped house and inlet connections, combined with ventilating manholes, furnish ample ventilation for sewers, and that such use of them is not objectionable, the construction of special ventilation devices would seem to be a needless expense and complication."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*. a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Accidents.

The Owner's Liability for Building Accidents. A statement of the law as interpreted in New York, where the owner of a building which collapsed with fatal results has been held liable for damages. 600 w. Eng Rec—March 10, 1900. No. 32954.

American Architecture.

American Architecture from a Foreign Point of View: New York City. Jean Schopfer. An illustrated article giving the effect produced by New York City on the mind of a European observer. 4500 w. Archt Rev—March, 1900. No. 33189 D.

Angles.

The Exterior Treatment of Sharp or Acute Angles in Street Building. A. W. Hennings. Read before the British Archt. Assn. Discusses the design of buildings to fit angular sites, when the land is valuable, considering special features, and giving many illustrations. Discussion. 6300 w. Builder—March 3, 1900. No. 32989 A.

Clay.

Clay Material as Used in the Best Modern Buildings. William D. Gates. On the improvement made in this material, its use and adaptability. Ill. 1000 w. Cal Arch't—Feb., 1900. No. 33171 C.

Dwellings.

Working Class Dwellings in Blocks. Thomas Blashill. Read before the British Archt. Assn. Discusses designs carried out by the London County Council, and the difficulties in the problem. Also general discussion. 9000 w. Builder—Feb. 17, 1900. No. 32867 A.

Glass.

Plate Glass. C. W. Brown. Brief review of the history of this industry, the manufacture and use. 2000 w. Jour of Pro of Am Inst of Archts—1899. No. 33140 D.

Hospitals.

Axioms and Principles of Modern Hospital Construction. Max Junghaendel. Read before the Technical Soc. of the Pacific Coast. A discussion of hospital construction and sanitation. 6200 w. Am Arch—March 10, 1900. No. 32931.

House-Building.

In the Cause of Intelligent House-Building. Suggestions for the improvement of building construction, the securing of better ventilation, and other details. 2000 w. Jour Gas Lgt—Feb. 20, 1900. No. 32822 A.

Library.

The John Ryland's Library, Manchester. Basil Champneys. Illustrated description of a building founded on English types. Also discussion. 5000 w. Jour Roy Inst of Brit Archts—Jan. 27, 1900. No. 32879 B.

Steel Skeleton.

The Steel Skeleton, or the Modern Sky-Scrapers. W. L. B. Jenney. Illustrated discussion of the engineering problems. 6400 w. Cal Arch't—Feb., 1900. No. 33168 C.

Tenements.

Model Tenements. Illustrated description of the plans which received the first prize in a competition held by the Charity Organization Society of New York. 1200 w. Eng Rec—March 3, 1900. No. 32811.

HEATING AND VENTILATION.

Condensation.

Pipes for Water of Condensation in Low-Pressure Steam Heating Apparatus (Die Kondenswasserableitung bei Niederdruck Dampfheizungen). With computations for the amount of water discharged, and the methods of providing for its return or removal. 2500 w. Gesundheits-Ingenieur—Feb. 28, 1900. No. 33254 B.

Cooling Dwellings.

Residence Cooling in St. Louis. Alfred Siebert. Describes method used by the writer. 600 w. Ice & Refrig—March, 1900. No. 32895 C.

The Refrigeration of Dwellings. E. Brueckner. Considers the cost and value, the systems, and scientific principles on which to calculate the amount required. 3500 w. Ice & Refrig—March, 1900. No. 32894 C.

Fireproofing.

Development of the Fireproofing of Buildings. Peter B. Wight. An illustrated review of the development of fireproof construction. 3300 w. Cal Arch't—Feb., 1900. No. 33169 C.

Hot-Water.

An Unusual Position for an Expansion Tank. Illustrated explanation of a hot-water heating system with a novel expansion tank in the cellar of the building below all the radiators. 1000 w. Eng Rec—March 17, 1900. No. 33051.

Manual of Steam and Hot-Water Heating. Thomas E. M'Neill. A detailed study of these systems. Ill. 1500 w. Met Work—March 17, 1900. Serial. 1st part. No. 33066.

Low Pressure.

Boilers for Low Pressure Hot Water Heating. Samuel Naylor. Read at meeting of the Inst. of Heat. and Ven. Engs., London. Discusses the important features necessary in the selection of boilers, giving results obtained with different kinds. 3400 w. Plumb & Dec—March 1, 1900. No. 32986 A.

Modern Methods.

Modern Methods of Heating and Ventilating Buildings as Practiced in the United States. James J. Lawler. Discusses methods in the use of steam and hot water. Ill. 3000 w. Cal Arch't—Feb., 1900. No. 33173 C.

Paris Exposition.

Metal Work Details of the Paris Exposition Buildings, Paris. Illustrated account of the general features of the grounds and the steel framing of the Palace of Civil Engineering and Transportation; explains the erection methods. 1500 w. Eng Rec—March 17, 1900. Serial. 1st part. No. 33050.

Notes on the Palaces of the Paris Exhibition, 1900. Charles Lucas. Exposition of works in course of completion, with illustrations and brief discussion. Both in French and English. 7500 w. Jour Roy Inst of Brit Archts—Feb. 24, 1900. No. 33079 B.

Schoolhouses.

Heating and Ventilating of Schoolhouses. R. C. Carpenter. A description of some of the methods employed, with suggestions for proportioning and constructing such systems. Ill. 6600 w. Br Build—March, 1900. No. 33166 D.

School Ventilating and Heating Apparatus. Review of a report by Alfred R. Wolff, describing the bad features in a high-school he examined, and giving his recommendations for their removal. 1500 w. Eng Rec—March 24, 1900. No. 33129.

Steam.

Heating by Steam at or Below Atmospheric Pressure. D. M. Nesbit. Read at meeting of the Inst. of Heat. and Ven. Engs., London. Discusses atmospheric steam heating, exhaust steam, etc. 2800 w. Plumb & Dec—March 1, 1900. No. 32987 A.

Piping for Steam Heating. A discussion by W. H. Bryan and W. S. Monroe on the methods of selecting pipe sizes. 1700 w. Eng Rec—March 17, 1900. No. 33052.

PLUMBING AND GASFITTING.

Residence.

Plumbing in Fifth Avenue Residences, New York. Illustrated description of the work in houses of the Astor estate, where the highest grade of work was required. 1200 w. Eng Rec—March 10, 1900. No. 32966.

Stables.

Stables on the Stern Country Estate. Illustrates and describes the arrangement of the farm buildings and horse stables on a large Tarrytown estate. 2500 w. Eng Rec—March 10, 1900. No. 32965.

MISCELLANY.

Electro-Mechanics.

Electrical Engineering for Architects. Arthur Vaughan Abbott. Considers the proper manner of introducing electricity, the uses to which it may be applied, and the safeguards which should be observed in its installation. 4500 w. Cal Arch't—Feb., 1900. 33172 C.

Landscape Architecture.

The Harvard Course in Landscape Architecture. An outline of the studies to be pursued in the first course of the kind established in the United States. 1000 w. Eng Rec—March 24, 1900. No. 33128.

Metal-Work.

Ornamental Metal Work. W. W. Kent. On the design, manufacture, and use of this material. Ill. 2800 w. Cal Arch't—Feb., 1900. No. 33174 C.

Office Methods.

The Office Methods of H. H. Richardson. Describes an architect's system of directing design without making sketches himself. 800 w. Eng Rec—March 3, 1900. No. 32810.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

The Alexander III. Bridge, Paris. J. Guenaire. Illustrated description of this handsome bridge and its construction. 1800 w. Sci Am—March 10, 1900. No. 32924.

Arch.

Hinged Concrete Arch Bridge Over the Neckar River at Kirchheim, Wur-

temberg. General view with brief description of a notable highway bridge of this type. 250 w. Eng News—March 29, 1900. No. 33190.

The Two-Hinged Arch. A discussion of the advantages of this type, with some comparisons with the three-hinged arch. 2000 w. Engr, London—Feb. 16, 1900. No. 32797 A.

Atbara.

An American Bridge in the Soudan (Eine Amerikanische Brücke im Sudan). F. C. Kunz. A general description of the Atbara bridge, by one of the engineers of the Pencoyd Iron Works, with numerous interesting photographs of the erection of the structure. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1900. No. 33236 B.

Davenport Bridge.

The Latest of the Large Mississippi Bridges. Illustrated description of a bridge of seven fixed spans and a draw span, having a total length of 2,310 feet. 700 w. Sci Am—March 17, 1900. No. 33009.

Deformation.

Two Instruments for Measuring Deformation and Stresses in Bridges (Zwei Instrumente für Messungen von Formanderung und Spannungen au Brücken). G. Mantel. Describing an adjustable clinometer and an extensometer for use in quantitative measurements of flexure and tension in framed structures. Three articles. 4000 w. Schweizerische Bauzeitung—Feb. 3, 10, 17, 1900. No. 33244 each B.

East River Bridge.

Falsework for Erecting the Manhattan Towers and End Spans, New East River Bridge. C. E. Fowler. Illustrated description with two-page plate of details. 3000 w. Eng News—March 8, 1900. No. 32940.

Expansion Bearing.

The Simple Rocker as a Substitute for the Roller Bearing (Das Einfache Pendel als Ersatz für das Rollen Kipplager). H. Kübler. A discussion of the use of a single rocker instead of a series of rollers as an expansion bearing for bridge trusses; with computations applied to a practical example. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33221 D.

Ferry Bridges.

Transfer Bridges. Illustrated descriptions of a suspended ferry, with a statement of its advantages. These bridges are from designs of Messrs. Arnodin and Palacio. 2300 w. Engng—Feb. 23, 1900. Serial. 1st part. No. 32869 A.

Foot-Bridge.

The Metal Foot-Bridge at Oberschönweide (La Passerelle Métallique d'Oberschönweide). An illustrated description of the new bridge over the Spree at Oberschönweide near Berlin. 1800 w. 1 plate. Génie Civil—March 3, 1900. No. 33208 D.

Foundations.

See Construction.

Lift Bridge.

Rolling Lift Bridge of the Boston Terminal (N. Y., N. H. & H. R. R.). Illustrated description of the six track draw bridge over Fort Point Channel. 3000 w. Eng News—March 15, 1900. No. 33088.

The Cuyahoga River Rolling Lift Bridge. Illustrated description of a single-track rolling bridge of 110-ft. clear span; the strains in the main and cantilever spans are given in detail. 800 w. Eng Rec—March 3, 1900. No. 32807.

Mississippi.

Temporary Bridge Across the Mississippi River, at St. Paul, Minnesota. Moving of Three 140-Foot Spans. A. W. Munster. Illustrations and brief explanation of this work. 400 w. Jour Assn of Engng Socs—Jan., 1900. No. 32835 C.

Railway Bridges.

Bridges Over the River Aire. Illustrated detailed description. 2000 w. Engr, Lond—March 9, 1900. No. 33032 A.

Bridge Work on the Baltimore & Ohio Railroad. Illustrated description of recent heavy double-track, plate-girder and truss bridges. 1000 w. Eng Rec—March 24, 1900. No. 33123.

Stresses.

Secondary Stresses in Trusses and Girders. Editorial discussion of views advanced concerning the advantages of the pin system. 1300 w. Engr, Lond—March 16, 1900. No. 33149 A.

CONSTRUCTION.

Foundations.

Improvements in Sinking Shafts (Neueres über Schachtabteufungen). P. Simons. A description of the method employed at Berne for sinking pits for the foundation piers of the Kornhaus Bridge, the Stadt-Theater, and other structures. 1200 w. Schweizerische Bauzeitung—Feb. 17, 1900. No. 33245 B.

The Inter-provincial Bridge, Ottawa, Canada. Illustrated description of the methods of putting down the foundations of piers in 20 to 60 feet of water-logged saw-dust and timber; with general details of the cantilever superstructure. 2200 w. Eng Rec—March 10, 1900. No. 32956.

Madagascar.

Public Works in Madagascar (Les Travaux Publiic à Madagascar). A. Dumas. A full account of the highway, railway, and harbour improvements initiated by the French government; with map of the railway from Tamatave to Tananarive. 3000 w. 1 plate. Génie Civil—Feb. 24, 1900. No. 33205 D.

Masonry.

The Present Status of Engineering Knowledge Respecting Masonry Construction. David Molitor. Considers earth pressure theories, retaining walls, fixed arches, three-hinged arches, concrete and iron arches, and concrete. Ill. 12400 w. Jour Assn of Engng Socs—Jan., 1900. No. 32834 C.

Reinforced Concrete.

The Computation of Concrete-Iron Beams with Upper Ribs (Berechnung der Betoneisenträger mit Oberen Rippen). Max R. von Thullie. The mathematical computations for the particular form of Hennebique beam in which the compression member is above, and the reinforcing metal rods below. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 1900. No. 33237 B.

Roads.

Road Construction in New Jersey. A statement of the special road-work in the State during 1899, and a report of the methods of construction and repair found most satisfactory. 3000 w. Eng Rec—March 24, 1900. No. 33124.

Subway.

History of Pennsylvania Avenue Subway, Philadelphia, and Sewer Construction Connected Therewith. George S. Webster and Samuel Tobias Wagner. Presents interesting features of the history of the work of abolishing grade crossings, and the construction of connected sewers. Ill. 7500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32838 E.

Tunnels.

A Tunnel Through Quicksand. Harrison P. Eddy. An interesting, finely illustrated account of a method of tunnelling through bad ground, in Worcester, Mass. 3700 w. Jour of Worcester Poly Inst—March, 1900. No. 33020 C.

The Reconstruction of the Ronco Tunnel (Reconstruction du Tunnel de Ronco). With plate of details showing the construction of the centering and vaulting; also the mathematical computations for the earth-pressure and pressure curves in the arch. 3000 w. 1 plate. Génie Civil—Feb. 17, 1900. No. 33203 D.

HYDRAULIC AND MARINE.

Breakwaters.

Difficult Repairs to the Alderney Breakwater. B. O. Townshend. Illustrated description from Proc. Inst. C. E. of the method of inserting large concrete blocks in the face of a wall exposed to heavy seas. 1400 w. Eng Rec—March 17, 1900. No. 33048.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Discussion of paper by Lewis M. Haupt. 2200 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32840 E.

Canals.

A Comparison of the Isthmian Canal Projects. George A. Burt. A careful review of both the Panama and Nicaragua plans, showing clearly their relative advantages, difficulties and costs. 3500 w. Engineering Magazine—April, 1900. No. 33294 B.

American Railroads and Canals. Editorial on the position of New York State in relation to the transportation trade, and the competition of other American ports and of the Canadian canals and Montreal. 1700 w. Engng—Feb. 16, 1900. No. 32795 A.

The Improvement of a Portion of the Jordan Level of the Erie Canal. Discussion of paper by William B. Landreth. 2200 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32843 E.

New York and Its Canals. Editorial on the Commissioner's report. 2000 w. Engr, Lond—Feb. 16, 1900. No. 32799 A.

New York's Canal Problem. William G. Raymond. A discussion of the report of the advisory committee appointed by the governor. 3300 w. R R Gaz—March 2, 1900. Serial. 1st part. No. 32770.

Santa Ana Canal. J. B. Lippincott. Extract from Report of the U. S. Geol. Survey. Illustrated detailed description of this canal and the water resources of southern California. 4200 w. Sci Am Sup—March 10, 1900. Serial. 1st part. No. 32927.

The Text of Two Much-Discussed Treaties. The full text of the Hay-Pauncefote and Clayton-Bulwer treaties, with editorial comment. 4000 w. Rev of Revs—March, 1900. No. 33061 A.

Waste of Money on Erie Canal. Discusses editorially the proposal to spend large sums of money on this canal, giving historical review of past waste on this enterprise. 1100 w. Loc Engng—March, 1900. No. 32751 C.

Dam.

The Assouan Dam on the Nile. An illustrated description of the methods of construction, which involve great engineering difficulties. 2800 w. Engng—March 9, 1900. No. 33026 A.

The Goose-Neck Canyon Dam. Illustrated description of a rock-fill dam 210-ft. high, with a facing of steel plates.

800 w. Eng Rec—March 10, 1900. No. 32955.

Drainage.

Progress of Drainage in New Orleans. Alfred Francis Theard. A study of the general plan as recommended in the report of the Advisory Board of Engineers, explaining the general features, and showing how far it has been carried out. Ill. 4500 w. Jour Assn of Engng Socs—Jan., 1900. No. 32836 C.

The Drainage of New Orleans. L. W. Brown. Illustrated description of the investigations made, and system adopted. 3500 w. Eng News—March 15, 1900. Serial. 1st part. No. 33090.

Dredge.

An Improved Suction and Force Dredge (Saug-und Druckbagger Neuer Konstruktion). H. v. Horn. Illustrated description of an improved dredge used in Haarlem, Holland. The spoil may be delivered to the shore or scow under pressure. 800 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33222 D.

A 6-Cubic Yard Dipper Dredge for Use on the Great Lakes. Brief illustrated description. 900 w. Eng News—March 1, 1900. No. 32763.

Filtration.

Filtration Plant for the Albany Water Supply. Illustrated description of this plant, designed and erected for the removal of typhoid bacteria. 2200 w. Sci Am—March 24, 1900. No. 33093.

The Albany Water Filtration Plant. Discussion of paper by Allen Hazen. 11500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32839 E.

The Efficiency of Mechanical Filtration. A review of recent criticisms of the operation of a mechanical filter in East Providence, R. I. 2000 w. Eng Rec—March 10, 1900. No. 32959.

Flow.

Experiments on the Flow of Water in the Six-Foot Steel and Wood Pipe Line of the Pioneer Electric Power Company, at Ogden, Utah. Second Series. Charles D. Marx, Charles B. Wing, and Leander M. Hoskins. Illustrated description of apparatus and methods used in experimental investigations, giving results. 5800 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32837 E.

New Hydraulic Data. A note on the importance of experiments on the flow of water in pipes, as affording a criterion for estimating the reliability of pipe formulas. 700 w. Eng Rec—March 10, 1900. No. 32953.

Ghent.

The Maritime Installation of the Port of Ghent (Les Installations Maritimes du Port de Gand). G. Leugny. A detailed account of the Terneuzen Canal, by which communication is to be made between Ghent and the North Sea by way of the Scheldt. 2000 w. Revue Technique—Feb. 10, 1900. No. 33213 D.

Great Lakes.

Proposed Plans for Regulating Works for Controlling the Level of Lake Erie. An illustrated description of the proposed design for the regulating works, with editorial discussion of the effect upon the levels of the St. Lawrence River. 4200 w. Eng News—March 22, 1900. No. 33119.

Ground Water.

The Danger of Ground-Water Supplies in the Tropics. Eug. Ackermann. A letter from the chief sanitary engineer of Para on the well water of Brazil and its pollution. 800 w. Eng Rec—March 3, 1900. No. 32812.

The Theory of Wells (La Theorie des Puits). L. Brouhon. A mathematical investigation of the laws of infiltration of ground water into wells, with the conditions governing flow and levels. 5000 w. 2 plates. Rev Univ des Mines—Feb., 1900. No. 33288 G.

Hydrometry.

A New Method for the Graphical Treatment of Hydrometric Problems (Neue Methoden für die Graphische Behandlung Hydrometrischer Probleme). Karl Goebl. Showing the method of plotting the data of many observations, and deducing the mean flow from the curves thus obtained. 7500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—March, 1900. No. 33249 G.

Laboratory.

The Hydraulic Laboratory of Cornell University. E. A. Fuertes. A brief history of this laboratory, built for the purpose of advancing hydraulic science. Ill. 5000 w. Jour N. E. Water Wks Assn—March, 1900. No. 32888 E.

Lighthouses.

Modern Lighthouse Apparatus. J. A. Purves. Illustrated descriptions of the mercury float *feu-éclair* light, and the spindle-eclipsing apparatus. 800 w. Nature—Feb. 22, 1900. No. 32784 A.

Mains.

Laying a 36-in. Water Main Under the Harlem River, New York. Brief description, with illustration, of the work of laying a main from 209th st., Manhattan, to Fordham Heights Landing. 500 w. Eng News—March 22, 1900. No. 33116.

Niagara.

Niagara Falls Industrial Number. A comprehensive, interesting, and fully illustrated account of the history, geology,

fine bridges, power plants, etc., with much information concerning the utilization of the energy. 12000 w. Sci Am Sup—March 3, 1900. No. 32757.

Organisms.

On Removing Organisms from Water. Frederick S. Hollis. A discussion of these organisms and the methods of removal, with general discussion by members. 3800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32891 E.

The Method of Removing Organisms from the Water in the Distributing Reservoir of the City of Syracuse, N. Y. An account of the condition of the water and the methods used, with general discussion. 3800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32890 E.

Reservoirs.

Covered Reservoirs and Their Design. Freeman C. Coffin. Considers the reservoirs built, the design, etc., and the cost of various sizes. 2 plates. 11200 w. Jour N. E. Water Wks Assn—March, 1900. No. 32893 E.

The Attica and Delphi Covered Reservoirs. A description of two circular basins, with brick walls and concrete bottoms, both presenting valuable facts concerning water-proof masonry. 1200 w. Eng Rec—March 24, 1900. No. 33126.

The Brightwood Reservoir, Washington, D. C. Illustrated description of a 415 x 300-ft. distributing reservoir with concrete lining of unusual construction and a cast-iron gate house. 1500 w. Eng Rec—March 3, 1900. No. 32804.

River Banks.

Protecting Banks Against River Currents. Illustrates and describes the protection given the banks of the Missouri River by the use of woven willow mattresses. 600 w. Ry & Engng Rev—March 17, 1900. No. 33082.

The Protection of the Banks of Wild Streams (Uferschutz bei Wildwässern). A. Lernet. Showing the practical arrangements of fascines and stone work for the protection of mountain torrents not otherwise regulated. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1900. No. 33233 B.

River Gauge.

An Electric Recording River Gauge. Illustrated description of an instrument for making a continuous record of the height of a river about half a mile from the recording station. 900 w. Eng Rec—March 10, 1900. No. 32957.

Stream Regulation.

The Regulation of a Section of the Goldbach in Gross-Otschehau (Die Regulierung einer Theilstrecke des Goldbaches in Gross-Otschehau). F. Krivanec. Describing the improvement of the slopes and protection of the banks by fascines. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—March, 1900. No. 33248 G.

Water Pipe.

Vitrified Water Pipe for Hartford. A statement of the reasons for using vitrified clay pipe for a water main, rather than cast-iron pipe or an open channel. 900 w. Eng Rec—March 24, 1900. No. 33125.

Water Purification.

Test of a Multiple-Effect Distilling Plant. A report of the duty of a plant for producing daily 60,000 gals. of drinking water from salt water, used by the U. S. Navy at Dry Tortugas. 2000 w. Eng Rec—March 17, 1900. No. 33049.

Water Distilling Plant at the Dry Tortugas. Illustrated description of the large multiple-effect distilling plant erected at Fort Jefferson, on the Dry Tortugas, Fla., to furnish water for the naval station and barracks. 4500 w. Eng News—March 29, 1900. No. 33192.

Water Supply.

Nation's Water Supply and Its Effective Control. C. E. Jones. Paper read before the British Assn. of Water-Works Engs., with general discussion. On the best means of securing effective control. 7500 w. Jour Gas Lgt—Feb. 27, 1900. No. 32919 A.

Waterways.

Benjamin Franklin's Experiments on Depth of Waterways. A letter from him, describing experiments made in 1768, establishing as a fact the retarding influence of shallow depths on the passage of boats; with comments by H. Goldmark. 1300 w. Eng Rec—March 10, 1900. No. 32968.

Water Works.

The Buffalo, N. Y., Water Works. Louis H. Knapp. An illustrated general description of the works. 1800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32889 E.

The Glasgow Water Works. James M. Gale. Describes the district from which the water supply is drawn, the means taken to secure it, and the works. 4500 w. Jour N. E. Water Wks Assn—March, 1900. No. 32892 E.

The Mount Royal Pumping Station, Baltimore, Md. Illustrated description of a pumping station designed by Henry Brauns, architect, and A. M. Quick, engineer, which is said to be the most elaborately constructed plant of the sort in service, its decorations being on the style of a modern high-class apartment house. 2000 w. Eng Rec—March 24, 1900. No. 33122.

The Water-Works of Bilston, England. James H. Fuertes. Illustrated description

of a plant in which there are two sets of pumps, one for high-pressure and the other for low, driven by the same steam end; a concrete vaulted reservoir is also used. 2600 w. Eng Rec—March 10, 1900. No. 33046.

The Water-Works of Merthyr Tydfil. Illustrated description of works mainly noteworthy for an overflow masonry dam 84-ft. high, built of hydraulic lime concrete, being the second British structure of the kind in which this material was used. 2600 w. Eng Rec—March 10, 1900. No. 32961.

MATERIALS.

Asphalts.

The Action of Water on Asphalts. George C. Whipple and Daniel D. Jackson. Read before the Brooklyn Engineers' Club. An account of investigations undertaken to determine the relative action of water upon some of the most important asphalts, with reference to their use for reservoir lining. 4200 w. Eng News—March 22, 1900. No. 33117.

The Action of Water on Asphalt. Brief review of the investigations made by G. C. Whipple and D. D. Jackson on the influence of water of various kinds on asphaltum. 700 w. Eng Rec—March 17, 1900. No. 33042.

Cements.

Hydraulic Cements. William S. MacHarg. A review of the manufacture, uses, successes and failures. 2500 w. Cal Arch't—Feb., 1900. No. 33170 C.

The Testing of Cement by Filtration (Essais des Cements par Filtration). M. L. Deval. An attempt to determine the value of cement for marine construction by testing for filtration of sea water through the specimen under pressure. The difficulty in obtaining comparable results appears to be great. 2000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33241 G.

Concrete.

The Computation of Concrete Footings for Walls and Columns. Abstract of an article by George H. Blagrove, in the *Contract Journal*, of London, Eng. 1100 w. Eng News—March 8, 1900. No. 32942.

Elastic Line.

Application of the Equations of the Elastic Line (Ermittlung der Gleichungen der Elastischen Linien). Professor Ramisch. A mathematical treatment of the application of the elastic theory to a beam of uniform cross section resting upon two supports and bearing loads at definite points. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1900. No. 33234 B.

Metal Protection.

Experiments on the Protection of Steel and Aluminum Exposed to Water. Discussion of paper by A. H. Sabin. 1800 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32842 E.

Timber.

Engineering Timber. R. Phillips. Read before the Gloucester Engng. Soc. Interesting information about various kinds of timber. 2500 w. Arch, Lond—Feb. 16, 1900. No. 32819 A.

MEASUREMENT.

Reconnoissance.

Methods of Determination of Latitude, Longitude and Solar Time in Reconnoissance Surveys. William S. Post. A compilation of methods, formulas, and references found useful in this work. 4500 w. Eng News—March 1, 1900. No. 32764.

Surveying.

A Method of Making a Farm Survey. G. B. Zahniser. Describes a method of land survey, and states its advantages. 1100 w. Eng News—March 29, 1900. No. 33196.

Surveys.

See Mining and Metallurgy, Mining.

MUNICIPAL.

Garbage.

Garbage Reduction Works at Pittsburg and Allegheny, Pa. Description of the plant and its operation. 3000 w. Eng News—March 29, 1900. No. 33195.

Highway Improvements.

The Modern Electric Railway and Permanent Street Improvement. C. E. McDowell. Gives instances of permanent improvement of the highways by trolley companies, and the benefits to suburban districts. 2300 w. Stone—Feb.-March, 1900. No. 32887 C.

Pavements.

Construction of Brick Pavements. George R. Grimes. Read at meeting of the Nat. Brick Mkrs. Assn. at Detroit, Considers the subject under seven heads. 3000 w. Brick—March 1, 1900. No. 32775.

Paving Brick and Brick Pavements. Daniel B. Luten. Read before the Indiana Engng. Soc. Illustrated report of the results of a study of different brick pavements and of a large number of tests of paving brick. 5000 w. Eng Rec—March 3, 1900. No. 32806.

Paving Brick and Brick Pavements. Arthur N. Talbot. A letter stating the relative advantages of different methods of testing paving brick. 1500 w. Eng Rec—March 24, 1900. No. 33130.

Standard Paving Brick Tests. A review of the work of the National Brick

Manufacturers' Assn., with the official list of tests adopted Feb. 9, 1900. Also editorial note on progress in brick paving. 3000 w. Eng Rec—March 17, 1900. No. 33044.

Sewage.

Bacterial Sewage Treatment, Owestry, England. A statement of the results attained with contact-bed methods of treatment. 1000 w. Eng Rec—March 10, 1900. No. 32962.

Recent Changes in Sewage Disposal, Worcester, Mass. Illustrated review of the history of the plant, explaining the peculiar difficulties in treating the 17,100,000 gals. of sewage from the city, and describing the sludge-pressing and filtration works recently added to the original chemical treatment works. 3500 w. Eng Rec—March 17, 1900. No. 33043.

Report on Sewage Sludge Deposits on the Experimental Coke Beds, London, England. Information from reports of Frank Clowes and A. C. Houston on the character of the deposits, the bacteria, and other matters of interest. 1100 w. Eng News—March 8, 1900. No. 32938.

The Clinton, Mass., Sewage Disposal System. Illustrated description of works noteworthy for the air pipes used to clean sewage basins and for concrete distributers for spreading sewage uniformly over filter beds. 500 w. Eng Rec—March 3, 1900. No. 32805.

The Operation of the Sewage Filter Beds at Brockton, Mass., in 1899. Information from the annual report of the city engineer. 1200 w. Eng News—March 29, 1900. No. 33194.

Sewerage.

The Drainage of the City of Mexico. A brief account of the nature of the work of two centuries to drain and sewer the city and valley of Mexico. 600 w. Eng Rec—March 24, 1900. No. 33120.

The Memorial of the Chicago Sanitary District. A statement of the reasons for making the drainage channel for Chicago's sewage a navigable waterway, and the necessity of improving the Illinois river to avoid disastrous floods which, the engineers have predicted from the inception of the work, would follow the discharge of 600,000 cu. ft. of water per minute into the river in its present state. 1500 w. Eng Rec—March 24, 1900. No. 33121.

Sewers.

A Large Storm-Water Sewer. Illustrated description of special intersections and crossings of main sewers in Boston. 600 w. Eng Rec—March 10, 1900. No. 32960.

Repairs to a Large St. Louis Sewer. Illustrates and describes the method of replacing the timber bottom of a sewer from 15 to 24 feet wide, by a concrete and brick invert. 500 w. Eng Rec—March 17, 1900. No. 33047.

Sewer Ventilation. A. Prescott Folwell. A description of the various methods employed, the results attained with each, and the present practice, as learned from recent investigations. 3900 w. Eng Rec—March 3, 1900. No. 32808.

Street Cleaning.

Street Cleaning in London. Describes methods used in St. Pancras vestry, which cost one-sixth of those in New York. 1300 w. Eng Rec—March 10, 1900. No. 32958.

Subways.

Subways for Street Pipes and Wires. Editorial on the need of such subways in New York, giving information concerning foreign cities, and suggesting the advisability of constructing them in connection with the rapid transit railway. Ill. 2500 w. Eng News—March 15, 1900. No. 33089.

MISCELLANY.

Address.

The Functions of the Engineer. William Henry Preece. Address delivered before the Glasgow Assn. of Students of the Inst. of Civ. Engs. 3000 w. Engr, Lond—Feb. 16, 1900. No. 32801 A.

Engineering Methods.

Working Methods of Engineering Contractors. James Brand. Facts from personal observations concerning earthwork excavations, tunnelling, rock cuttings, masonry, cranes, concrete, coffer dams and pumping, etc. 7700 w. Engr, Lond—March 9, 1900. No. 33033 A.

Plateways.

Plateways. A. Holt. Excerpt of a paper read before the Students' Engng. Soc., with editorial. An article advocating the practicability of the plateway system, and its power to revolutionize inland transportation. 6000 w. Automotor Jour—Feb., 1900. No. 32813 A.

Surveys.

Railroad Preliminary Survey by Stadia. John H. Lary. Description of work, with statement of the difficulties encountered. Discussion. 1800 w. Jour W Soc of Engs—Feb., 1900. No. 33330 D.

Recent Stadia Topographic Surveys: Notes Relating to Methods and Cost. William B. Landreth. The work reported was in connection with the proposed deep waterway on the Oswego-Mohawk-Hudson route, through New York State. Maps. 1500 w. Pro Am Soc of Civ Engs—March, 1900. No. 33305 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Laying a Telephone Cable Under Difficulties. A brief illustrated account of the laying of a cable to Martha's Vineyard. 1300 w. Elec Rev, N. Y.—March 14, 1900. No. 33012.

Cables.

Ocean Cables and International Commerce (Die Seekabel im Weltverkehr). A review of the present extent and importance of ocean cables, and a special description of the new German cable-laying steamer "Von Podbielski." 4000 w. 1 plate. Stahl und Eisen—Feb. 15, 1900. No. 33255 D.

Exchange.

Cincinnati Walnut Hills Telephone Exchange. H. E. Hall. Illustrated detailed description of this exchange, given as an example of improvements now under way in Cincinnati. 1800 w. Elec Wld & Engr—March 10, 1900. No. 32969.

Gutta Percha.

Gutta Percha (Die Guttapercha). E. Veyeraband. A general account of the production and properties of gutta-percha, with especial reference to its applications in electrical work. 4500 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33270 B.

The Supply of Gutta-Percha. Hawthorne Hill. On the sources of supply, and the demand, with related information. 1200 w. Elec Rev, N. Y.—March 7, 1900. No. 32949.

Space Telegraphy.

The Guarini Automatic Repeater (Repétiteurs Automatiques Guarini). Detailed description of an apparatus by which the range of communication can be extended from one station to another. 2000 w. L'Electricien—March 17, 1900. No. 33287 B.

Stray Currents.

See Street and Electric Tramways.

Telegraphs.

Improvements in Wheatstone Automatic Telegraph Apparatus. Illustrated description of the improved apparatus. 800 w. Elec Rev, Lond—March 2, 1900. No. 32983 A.

Underground.

Underground Work of the Illinois Telephone and Telegraph Company. Illustrated detailed description. 1700 w. W Elect'n—March 17, 1900. No. 33081.

DISTRIBUTION.

Alternating Currents.

A New Method of Tracing Alternating Current Curves. Fitzhugh Townsend. Describes a method recommended for its simplicity, accuracy and rapidity. 1800 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33065 D.

Principles of Alternating Current Distribution. Francis B. Crocker. Gives the principles of alternating currents, considering briefly the chief facts as a basis for study and calculations concerning alternating current-lines, transformers, etc. 6000 w. Sch of Mines Qr—Jan., 1900. No. 33016 D.

The Application of Complex Quantities to Alternating Current Circuits. Harold B. Smith. Explains methods of calculation. Diagrams. 2500 w. Jour of Worcester Poly Inst—March, 1900. No. 33023 C.

Aluminum.

Aluminum Electrical Conductors. Frank C. Perkins. Illustrated description of the works of the Pittsburg Reduction Company, with information relating to the use of this metal. 4000 w. W Elect'n—March 10, 1900. No. 33062.

Cables.

Cables for Electric Light and Power in Mine Shafts. Sydney F. Walker. Discusses the problem of protecting the cables from damage, and of keeping the water from destroying the insulating properties. 3500 w. Col Guard—March 2, 1900. No. 32976 A.

Cables for Electric Light and Power in Mine Shafts. G. W. Bousfield. Remarks on the opinions advanced by Sydney F. Walker in a recently published article. 1400 w. Col Guard—March 16, 1900. No. 33144 A.

Coils.

See Mechanical Engineering. Automobilism.

Storage Batteries.

The Regulation of Storage Battery Voltage. Roderick Macrae. Illustrates and describes some of the methods employed in operating storage batteries on distributing mains, discussing the different arrangements. 2400 w. Elec Wld & Engr—March 24, 1900. No. 33138.

Subways.

See Civil Engineering. Municipal.

Three-Wire.

Extension of Electrical Supply from

Three-Wire Stations. Alton D. Adams. Discusses three plans for extending the service area. 1800 w. Elec Wld & Engr—March 17, 1900. No. 33070.

Some Notes on Balancing and Boosting Sets. R. Wightman. Deals with the balance, its functions and design, noticing how these are affected by the addition of the boosters to the balancing set. 1800 w. Elec Rev, Lond—March 2, 1900. No. 32982 A.

Wiring.

Municipal Wiring a Failure in Boston. Alton D. Adams. Comment on information given in the report of the chief electrician of the wire department. 800 w. Elec Wld & Engr—March 10, 1900. No. 32972.

The Rearrangement of a Distribution System at Constant Resistance (Ueber Widerstandstreue Ungestaltung Elektrischer Leitungsnetze). J. Herzog and C. P. Feldmann. A graphical method of computing the conductors in changing or rearranging a distribution system. 3500 w. Elektrotech Zeitschr—March 1, 1900. No. 33274 B.

The Wiring of Houses for the Electric Light. Ed. C. de Segundo. Discusses proper methods of wiring, and the things *not* revealed by an insulation test. 1900 w. Elec Rev, Lond—Feb. 23, 1900. No. 32882 A.

ELECTRO-CHEMISTRY.

Alkalies.

The Electrolytic Production of Soda and Chlorine. James F. Hobart. The first paper is introductory. 1700 w. Am Elect'n—March, 1900. Serial. 1st part. No. 32861.

Copper Plating.

Electro-Deposition of Copper from Alkaline Solutions. Sherard Cowper-Coles. Illustrates and describes a plant recently erected at the works of the Société des Mines et Founderies de Zinc de la Vieille-Montague in Belgium, for electro-depositing copper upon metallic zinc sheets. 400 w. Elec Rev, Lond—Feb. 16, 1900. No. 32823 A.

Ozone.

The Industrial Production of Ozone. From *La Nature*. Illustrated description of the Otto Rotary Ozonizer. 900 w. Sci Am Sup—March 10, 1900. No. 32930.

The Ozone Industry (L'Industrie de l'Ozone). M. H. Otto. An exhaustive discussion of the generation of ozone and its applications, especially in the sterilization of water. 10000 w. Mem Soc Ing Civ de France—Feb., 1900. No. 33291 G.

Progress.

Recent Progress in Electro-Chemistry. Herbert R. Kingman. Notes the theories and principles from which the commercial industries of this field have developed, and reviews the progress. 3500 w. W Elect'n—March 10, 1900. Serial. 1st part. No. 33076.

ELECTRO-PHYSICS.

Alternating Currents.

Fundamental Ideas of Alternating Currents. Dugald C. Jackson. Read at convention of the Northwestern Elec. Assn. A statement of the elementary electric and magnetic principles which relate to the flow of alternating currents. 1500 w. Elec Wld & Engr—March 17, 1900. Serial. 1st part. No. 33072.

Aluminum Electrodes.

The Luminescence of Aluminum Electrodes. W. S. Andrews. Illustrated description of a curious experiment with aluminum-carbon cells. 500 w. Elec Wld & Engr—March 24, 1900. No. 33137.

Interrupter.

Comparison of Various Forms of Wehnelt Interrupter (Comparaison de Diverses Formes de l'Interrupteur de Wehnelt). A. Turpain. A communication to the French Academy, giving quantitative measurements of the results, using two forms of Wehnelt interrupter, and one of Foucault's design. 1200 w. Comptes Rendus—Feb. 12, 1900. No. 33230 D.

Magnets.

Steels for Magnets. F. Osmond. From *Comptes Rendus*. An account of investigations carried on in the Sorbonne Laboratory of General Chemistry. 600 w. Metallographist—Jan., 1900. No. 32827 E.

Radiation.

Becquerel Rays. An illustrated account of these rays and their effect, and a comparison with the Röntgen rays. 1100 w. Elec Rev, Lond—March 9, 1900. No. 33056 A.

Latest Developments with the X-Rays. John Trowbridge. Discusses the present state of knowledge, the art of using the X-rays, the methods of obtaining them, and information gained by their use. 4800 w. Ap Pop Sci M—April, 1900. No. 33177 C.

The Electric Charge Derived from the Divertible Rays of Radium (Sur la Charge Electrique des Rayons Déviables du Radium). M. and Mme. Curie. A communication to the French Academy discussing those rays emitted by radium which can be deviated by a magnetic field. 1500 w. Comptes Rendus—March 5, 1900. No. 33232 D.

X Rays and Discharge (Rayons X et Décharge). G. Sagnac. A communication to the French Academy discussing

the relations of the X rays to the electric discharge, and giving a generalisation of the notion of cathodic rays. 1500 w. Comptes Rendus—Feb. 5, 1900. No. 33-229 D.

X-Rays in Examination of Coal. An account of the investigations made by Prof. Henri Couriot, by radiometric analysis. 1100 w. Eng & Min Jour—March 17, 1900. No. 33075.

Spark.

A Wave-like Motion of an Electric Spark (Ueber eine Wellen förmige Bewegung Elektrischer Funken). E. Ruhmer. With reproductions of photographs of the peculiar forms and a discussion of the conditions and causes of the phenomena. 3000 w. Elektrotech Zeitschr—Feb. 22, 1900. No. 33273 B.

Volta Effect.

Contact Electricity. Editorial on the controversy, noting its antiquity and reviewing its history. 1400 w. Engng—Feb. 16, 1900. No. 32793 A.

Waves.

On Electric Touch and the Molecular Changes Produced in Matter by Electric Waves. Jagadis Chunder Bose. Abstract of a paper read before the Royal Soc. An account of investigations made in an attempt to reduce the action of contact-sensitiveness of metals to a systematic behavior. 3500 w. Elect'n, Lond—Feb. 23, 1900. Serial. 1st part. No. 32880 A.

GENERATING STATIONS.

Accumulator.

The Majert Accumulator (Accumulateur Majert). Describing especially the method of planing the sheet lead into ridges, furnishing a plate of greatly extended surface, well adapted for receiving the active material. 2500 w. Revue Technique—Feb. 10, 1900. No. 33214 D.

Alternating.

A 220-Volt Two-Wire Alternating Current Central Station. W. U. Zurfluh. Describes a plant installed at Rockford, Ohio. 1100 w. Am Elect'n—March, 1900. No. 32856.

Armatures.

Double-Wound Armatures. Alton D. Adams. Considers the class of double-wound armatures in which each winding is entirely independent of the other and has its own commutator. 2700 w. Am Elect'n—March, 1900. No. 32859.

Cells.

Cells for Accumulators (Ueber Akkumulatoren-Kasten). J. B. Hohn. Discussing especially the properties of hard rubber as used for the containing cells for accumulators. 800 w. Elektrochem Zeitschr—March 1, 1900. No. 33286 D.

Design.

The Design and Construction of Central Stations. C. Stanley Peach. Explains briefly the origin and development, and reviews the use, significance and design, studying the subject in detail. 6000 w. Builder—March 10, 1900. No. 33-038 A.

Dynamos.

Fly-Wheel Continuous Current Generators (Gleichstrom-Schwungradmaschinen). F. Collischonn. Illustrating and describing vertical and horizontal engines in which the electric generator for continuous current is built-up upon the rim of the fly-wheel. Details of the windings and connections are given. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33220 D.

New Steam Dynamos for Electric Traction at Hull. Illustrated description of two generating sets recently installed in the Hull Corporation Tramway Power Station. 1000 w. Elec Rev—March 16, 1900. No. 33162 A.

Some Mechanical Details of Dynamo Design. E. Kilburn Scott. Part first discusses the bedplate, field magnets, slide rails, winding cup, armature core, etc. Ill. 1300 w. Elec Rev, Lond—March 2, 1900. Serial. 1st part. No. 32984 A.

Electrical Energy.

Electrical Energy in Bulk. Editorial comment on the large number of engineering projects before Parliament, and the attitude of English municipalities. 2700 w. Engng—Feb. 16, 1900. No. 32-792 A.

Electric Supply.

City-Road Electric Supply Station. Illustrated description of an English station. 3000 w. Engr, Lond—Feb. 23, 1900. No. 32876 A.

Ingleton Water-Power Electric Supply Works. Illustrated description of a British plant for village electric lighting. 1200 w. Elect'n, Lond—Feb. 16, 1900. No. 32818 A.

The Willesden Works of the Metropolitan Electric Supply Company. Illustrated detailed description of the works named and of the coaling arrangements. 2200 w. Elec Eng, Lond—March 9, 1900. Serial. 1st part. No. 33041 A.

Equipment.

Economic Equipment of Electric Stations. Alton D. Adams. Discusses the three general plans for the equipment of these generating stations. 3000 w. Elec Wld & Engr—March 3, 1900. No. 32-902.

Exciter.

A New Method of Exciting Alternators (Ein Neues Erregungssystem für Wechselstrom Maschinen). A system of

auxiliary brushes are arranged so as to deliver a current from the armature of the alternator for exciting the field. 3000 w. Elektrizität—March 3, 1900. No. 33-285 B.

Legislation.

Swiss Legislation Concerning Safety in Electric Plants (Sicherheitsvorschriften über Elektrische Anlagen in der Schweiz). The full text of the Swiss law of July 7, 1899. Three articles, 10,000 w. Elektrotech Zeitschr—March 1, 8, 15, 1900. No. 33277 each B.

Lighting Stations.

The Electric Lighting Stations at St. Luke's, Clerkenwell, and at Wandsworth. Editorial describing these two plants and the three entirely different types of generating plant in the same station. 3000 w. Engng—Feb. 16, 1900. No. 32794 A.

Maximum-Demand.

The Maximum-Demand System of Charging for Electrical Energy. W. Perren Maycock. An explanation of the system, aiming to make it plain to the uninitiated. 2700 w. Elec Rev, Lond—March 2, 1900. No. 32985 A.

Municipal Plant.

Wallingford, Conn., Municipal Electric Lighting Plant. Thomas C. Perkins. Illustrated description of the interesting features of a small plant. 1500 w. Elec Wld & Engr—March 17, 1900. No. 33-068.

Paralleling.

The Action of Parallel-Connected Alternators (Ueber das Verhalten Parallel Geschalteter Wechselstrommaschinen). Hans Görges. Giving a graphical method for showing the action, as well as differential equations for the alternations. 7500 w. Elektrotech Zeitschr—March 8, 1900. No. 33278 B.

Power Plants.

The Tariffville Plant of the Hartford Electric Light Company. Illustrated description of the construction of a concrete dam and power station for a 1,250 h.p. plant, with notes on the electrical features. 2300 w. Eng Rec—March 24, 1900. No. 33127.

Switchboard.

See Measurement.

Test.

The Guarantee Test of the Zürich Electric Plant (Abnahmeversuche der Dampf-Dynamo Anlage des Elektricitätswerkes der Stadt Zürich). H. Wagner. A detailed account of the test of two direct-connected steam dynamo sets of 1000 h.p. each. 4500 w. Elektrotech Zeitschr—Feb. 22, 1900. No. 33272 B.

Transformers.

A Transformer for Furnishing Large Currents. Illustrated description of a transformer of about 450 K.-W. capacity, built for the Acheson Graphite Co. 800 w. Eng News—March 8, 1900. No. 32-943.

HEATING AND WELDING.

Annealing.

The Electric Process of Annealing Armor-Plate. An illustrated detailed description. 2500 w. Ir & Coal Trds Rev—March 16, 1900. No. 33154 A.

Thermostat.

An Electrical Thermostat. William Duane and Charles A. Lory. Illustrates and describes the construction of an electrical thermostat used in research work when it was necessary to keep the temperature of a bath constant for a considerable length of time. 1200 w. Am Jour of Sci—March, 1900. No. 32746 D.

Water Heating.

A Novel Application of Electric Heat. E. J. Hart. Brief account of a plan for warming the water of Lake Superior before admitting it to the city water-works system, thus remedying the trouble occasioned by "needle ice." 600 w. Elec Wld & Engr—March 17, 1900. No. 33071.

LIGHTING.

Air Pump.

The Berrenberg Pump for Exhausting Incandescent Lamps (Berrenberg'sche Luftpumpe für die Glühlampen fabrikation). The preliminary exhaustion is effected by a rotary pump and the final by a compound piston pump, using oil to fill all clearance spaces. 2500 w. Elektrotech Zeitschr—March 15, 1900. No. 33-282 B.

Arc Lighting.

Cost of Arc Lighting. Discussion of paper by H. H. Wait. 6000 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33063 D.

Cable Breakdowns.

On Electric Lighting Cable Breakdowns. Gisbert Kappe, in *Electrotechnische Zeitschrift*. Reviews the causes of breakdowns, showing them to be often due to the improper connections. 3000 w. Elec Rev, Lond—March 9, 1900. Serial. 1st part. No. 33057 A.

Car Lighting.

See Railway Affairs, Motive Power.

Lamp Testing.

The Lamp-Testing Department of the New Orleans Edison Company. Lyman C. Reed. Describes the method of testing. Ill. 1300 w. Am Elect'n—March, 1900. No. 32857.

Lighting Stations.

See Generating Stations.

Nernst Lamp.

The Nernst Lamp. W. McA. Johnson. Gives a brief account of the first commercial application of the Nernst lamp, in Gottingen, Germany, the home of the inventor. 1000 w. Elec Wld & Engr—March 3, 1900. No. 32901.

Sub-Marine Lamp.

The Yale Sub-Marine Arc Lamp. Southard Hay. An illustrated account of this lamp and the satisfactory tests. It is expected that it will prove satisfactory for submarine photography. 1300 w. Yale Sci M—March, 1900. No. 32945 C.

MEASUREMENT.

Legislation.

The Law for the Measurement of Electricity (Das Gesetz betreffend die Elektrischen Maasseinheiten). F. Uppenborn. A discussion of recent legislation in Germany, regarding the measurement of electricity for sale. 4000 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33271 B.

Meters.

The Calibration of Meters for Multiple Circuits (Die Aichung von Mehrleiterzählern). W. Marek. A simple method of calibration by comparing a rotary meter with a pendulum meter. 1500 w. Elektrotech Zeitschr—March 1, 1900. No. 33275 B.

Standardization.

American Electrical Engineering Standardization. C. F. Guilbert. Comments on the report of the committee by a French engineer, also editorial. 6000 w. Elec Wld & Engr—March 3, 1900. No. 32903.

Standards.

The Facilities Afforded by the U. S. Office of Standard Weights and Measures for the Verification of Electrical Standards and Electrical Measuring Apparatus. Frank A. Wolff, Jr. Describes what has been accomplished, and gives a brief history of the units of reference. 4800 w. Elec Wld & Engr—March 10, 1900. No. 32971.

Switchboards.

Switchboard Instruments—Ammeters and Voltmeters. William Baxter, Jr. Diagrams illustrating the principles upon which nearly all the ammeters and voltmeters in actual use are constructed, are given and explained. 2000 w. Am Mach—March 8, 1900. No. 32909.

Testing.

A Differential Method of Testing Rail Bonding and Return Circuits for Electric Railways. Lincoln Nissley. Describes a method successfully employed by the writer in a recent test on one of the largest consolidated roads. 2800 w. St Ry Rev—March 15, 1900. No. 33004 C.

Engineering Tests on Direct Current Electrical Machinery with Preliminary Tests on the Properties of Conductors. George F. Sever. Gives description of the methods of dynamo and motor operation and testing, experimental work, etc. Ill. 7000 w. Sch of Mines Qr—Jan., 1900. No. 33017 D.

Voltmeter.

Reflecting Voltmeter of Large Range (Spiegel-Voltmeter mit Weitem Messbereich). W. Thiermann. A description of an instrument constructed for the Technical High School at Hanover, with a range from 750 volts down to 0.0007 volt. 3500 w. Elektrotech Zeitschr—March 15, 1900. No. 33281 B.

POWER APPLICATIONS.

Accumulators.

See Mechanical Engineering, Automobilism.

Constant Potential.

Methods of Controlling Direct Connected Motors. William Baxter, Jr. The discussion is confined to the constant potential type, and fully illustrated. 2200 w. Mach, N. Y.—March, 1900. No. 32853.

Controllers.

Controllers for Electric Motors (Die Steuerschalter für Elektrische Motoren). A full discussion of the principles of construction, with numerous diagrams, and photographs of working controllers. 3500 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33225 D.

Designs.

Designs for Combined Alternating and Direct-Current Machines. J. C. Brocksmith. Gives designs and working drawings for a type of machines useful in experimental and laboratory work. Describes the working in different ways. 3500 w. Am Elect'n—March, 1900. No. 32860.

Factory Driving.

Electricity at Lyman Cotton Mills. Describes an auxiliary two-phase installation used to drive four large mills when the hydraulic plant is inadequate. 600 w. Eng Rec—March 3, 1900. No. 32809.

The Electrical Transmission of Power (Transmission de Force par l'Electricité). An illustrated account of the use of "group driving," as installed in the "Louisiane" spinning and weaving mills at Ghent. 2500 w. Génie Civil—Feb. 17, 1900. No. 33202 D.

Friction.

The Friction of Unloaded Induction Motors (Ueber die Leerlaufreibung bei

Induktions Motoren). F. Blanc. A mathematical discussion of Braun's method, showing how possible errors in its application may be avoided. 2500 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33269 B.

Induction Motors.

Notes on Single-Phase Induction Motors and the Self-Starting Condenser Motor. Charles Proteus Steinmetz. Theoretical discussion and calculation. 6000 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33064 D.

Mine Power.

Electricity in Anthracite Coal Mining. Ellis E. Brown. Considers the advantages and disadvantages of using electric power in transporting the coal from the working face to the breaker, and for the removal of water from workings. Ill. 3000 w. Jour of Worcester Poly Inst—March, 1900. No. 33022 C.

Motors.

Open v. Enclosed Motors for Stationary Work. Charles Leven. Discusses both types and favors the open motor. 1200 w. Elec Rev, Lond—March 9, 1900. No. 33058 A.

See Mechanical Engineering, Automobilism.

Organ Power.

Electric Motor Applied to Organ. Albert Siebert. Describes the manner of applying the power, and the advantages of the arrangement. 1000 w. Mod Mach—March, 1900. No. 32846.

Pump.

The Riedler Express Pump with Electric power (Reidler-Expresspumpen mit Elektrischem Antrieb). The application of the mechanically actuated valves of Prof. Riedler's design enables electrically driven pumps to be operated at high speed. 1000 w. Elektrizität—Feb. 17, 1900. No. 33284 B.

Spezia.

The Installation of Electric Power at the Arsenal at Spezia (L'Energia Elettrica pel Regio Arsenale Militare Marittimo della Spezia). A. Raddi. A general account of the proposed plan to supply the arsenal with electric power and light derived by the River Magra. 2000 w. L'Elettricita—Feb. 10, 1900. No. 33283 B.

MISCELLANY.

Address.

Inaugural Address of Dr. Edward Hopkinson to the Manchester Section of the Institution of Electrical Engineers. Abstract. Discusses English electrical engineering. 3500 w. Elect'n, Lond—March 16, 1900. No. 33163 A.

Development.

Electrical Development in the United Kingdom. Discusses the effect of municipalization and legislation upon the development of electrical enterprise in England. 5500 w. Engr, Lond—March 2, 1900. No. 32979 A.

Exposition.

Electricity at the Pan-American Exposition. Frank C. Perkins. Brief illustrated account of the electrical attractions to be carried out. 1700 w. Elec Wld & Engr—March 24, 1900. No. 33139.

Italy.

Electrical Progress in Italy During 1899. Enrico Bignami. A survey of the progress for the year. 1200 w. Elec Rev, N. Y.—March 7, 1900. No. 32950.

Medical Electricity.

On the Applications of Electricity in Medical and Surgical Practice. H. Lewis Jones. Read before the Inst. of Elec. Engs. Discusses the apparatus and methods, some of the difficulties met and problems to be solved. 8000 w. Elect'n, Lond—March 9, 1900. No. 33055 A.

GAS ENGINEERING

Acetylene.

Acetylene and the Manufacture of Mineral Blacks. Georges F. Jaubert. From *La Revue des Produits Chimiques.* An account of experiments made for ascertaining a process suitable for the manufacture on a large scale. 2500 w. Sci Am Sup—March 17, 1900. No. 33010.

Acetylene Lamps for Miners' Use. K. Baumgartner, in *Allgemeine Bergmännische Zeitschrift.* Illustrates and describes a lamp made by the Velo Company, of Dresden-Löbtau. States the advantages and disadvantages. 1200 w. Col Guard—Feb. 23, 1900. No. 32873 A.

The Generation and Use of Acetylene. Concerning the appliances required for a complete acetylene installation, and the precautions to be observed in its erection. Ill. 2500 w. Builder—March 3, 1900. No. 32988 A.

The II. International Congress for the Carbide and Acetylene Industry (II. Internationaler Congress für Carbid und Acetylen-Industrie). H. Koechlin. A general review of the exposition at Buda-

pest, with descriptions of the more important exhibits. 500 w. Oesterr Monatschr f d Oeffent Bandienst—March, 1900. No. 33250 G.

Address.

Inaugural Address before the Manchester District Institution of Gas Engineers. T. N. Ritson. Considers matters of interest to the gas industry. 8500 w. Jour Gas Lgt—Feb. 27, 1900. No. 32918 A.

Inaugural Address of D. Irving before the Southern District Association of Gas Engineers and Managers. Considers the demand for coal, spontaneous combustion, and matters of interest to the gas industry. 5000 w. Jour Gas Lgt—March 6, 1900. No. 33015 A.

Presidential Address Before the Midland Association of Gas Managers. J. Ferguson Bell. Reviews subjects of interest to the gas industry. 6700 w. Gas Wld—March 10, 1900. No. 33040 A.

Ammonia.

Ammonia: Its Saving and Concentration. George Osius. Read before the Michigan Gas Assn. A description of how to save it and how to prepare it for the market. 2000 w. Pro Age—March 1, 1900. No. 32786.

The Production of Liquor Ammoniæ from Gas Liquor. An outline of the recent work of Dr. Otto Pfeiffer, concerning improvements in the process of manufacture which he claims have resulted in a reduction in the cost of production. 1800 w. Jour Gas Lgt—March 13, 1900. No. 33101 A.

Carbide.

Calcium Carbide as a Means of Conversion of Work (Das Calcium Carbid als Mittel zur Arbeitsübertragung). E. Neuberg. An analysis of the thermochemical efficiency of the electric furnace in the production of carbide. 2500 w. Elektrotech Zeitschr—March 1, 1900. No. 33276 B.

The Manufacture of Calcium Carbide and its Relation to the Iron Industry (Die Calciumcarbidfabrication und deren Zusammenhang mit der Eisenindustrie). H. Liebetanz. A review of the carbide industry, showing that the use of furnace gas as a source of power may render its production advantageous in connection with iron works. Serial. Part I. 2500 w. Stahl und Eisen—March 1, 1900. No. 33256 D.

Charging.

The Mechanical Charging and Discharging of Gas Retorts (Chargement et Déchargement Méchaniques des Cornues à Gaz). An illustrated description of the Brackenburg hydraulic apparatus, as applied to the Lachomette retorts and furnaces. 1800 w. 1 plate. Génie Civil—March 10, 1900. No. 33211 D.

Coal Analysis.

A Laboratory Method for the Analysis of Coals for Gas Manufacture. J. G. A. Rhodin. Read before the Manchester section of the Soc. of Chem. Ind. Detailed description of apparatus used and manner of working. 3000 w. Gas Wld—Feb. 17, 1900. No. 32817 A.

Distribution.

Pumping Gas Five Miles at Twenty Pounds Pressure. F. H. Shelton. Read before the New England Assn. of Gas Engs. Describes a recently constructed high-pressure system which has worked successfully from the start. General discussion also. 8000 w. Am Gas Lgt Jour—March 5, 1900. No. 32848.

Fire-Brick.

Properties of Fire-Brick. Charles Feery. Considers each constituent which appears in an analysis of fire clay and the facts derived from the study. 2500 w. Gas Engs' Mag—March 10, 1900. No. 33161 A.

Fuel.

Some Notes on Oil and Tar Burning. Benjamin J. Allen. Read before the New England Assn. of Gas Engs. An account of experiments from the experience of the writer, with general discussion. Ill. 5000 w. Am Gas Lgt Jour—March 26, 1900. No. 33131.

Fuel Gas.

The Present Status of Fuel Gas. John R. Lynn. Read at meeting of the Ohio Gas Lgt. Assn. Discusses the possibility of manufacturing an economical gas for fuel purposes to take the place of natural gas, which is failing in quantity. 2800 w. Am Gas Lgt Jour—March 26, 1900. No. 33132.

Gas Compression.

The Rapid Delivery of Gaseous Bodies into Reservoirs under Pressure (Ueber Beziehungen der Pressungen Gasförmiger Körper au Stauflächen in Hohen Geschwindigkeit). Paul Fuchs. An examination of the action of a pressure-blower in delivering gas into a holder; with curves showing the effects of various pressures and velocities. 1200 w. Gesundheits-Ingenieur—Feb. 15, 1900. No. 33253 B.

Gasholders.

On Gasholders. Baurath Hacker. Abbreviated translation of a paper from the Journal of the Union of German Engineers. Discusses the uncertainty as to the distribution of wind pressure in the usual modes of construction, etc. Ill. 2300 w. Gas Wld—Feb. 24, 1900. No. 32884 A.

Gas Making.

Reversible Reactions in Gas Making. Abstract translation of paper by Dr. Smits, in *Het Gas*. Explains the reactions. 1200 w. Gas Wld—Feb. 24, 1900. No. 32885 A.

Gas-Testing.

Gas Companies and Peripatetic Gas-Testing. Norton H. Humphreys. A discussion of the objections to the portable photometer system. 2500 w. Jour Gas Lgt—March 13, 1900. No. 33104 A.

Gas Wells.

Gas-Well Sections in the Upper Mohawk Valley and Central New York. Charles S. Prosser. Gives descriptions of the various wells, and of samples, with discussions of records. 2700 w. 5500 w. Am Geol—March, 1900. No. 32952 D.

Illumination.

Hygienic Lighting. F. Erismann. Translated from *Journal für Gasbeleuchtung*. Considers the quantity of light, the contamination of the air, heating, radiation, effect on the eye, etc. 5800 w. Pro Age—March 15, 1900. No. 33011.

Incandescent.

Sugg's Increased Pressure and Christiania Incandescent Burner Systems. Illustrates and describes apparatus for high-power incandescent gas lighting, and the operation. 1800 w. Jour Gas Lgt—March 13, 1900. No. 33103 A.

Mains.

The Distribution of Gas Under Pressure. A statement of a practical test of gas distribution under 20 pounds pressure. 1200 w. Eng Rec—March 10, 1900. No. 32964.

Under-Water Gas Main Construction. Discussion at meeting of the New England Assn. of Gas Engineers, opened by John A. Coffin. Ill. 6000 w. Am Gas Lgt Jour—March 19, 1900. No. 33073.

Meters.

Meter Testing. Paul Doty. Read before the Michigan Gas Assn. A description of meter testing and records and results of testing over 5000 meters. 1800 w. Pro Age—March 1, 1900. No. 32787.

Napthalene.

The Presence of Naphthalene in Coal Gas: A Novel Theory. R. W. Allen. A summary of the contents of a paper read at meeting of the London section of the Soc. of Chem. Ind. Gives experimental data presenting this question in a new aspect. Also editorial, correspondence, and discussion. 9000 w. Jour Gas Lgt—March 13, 1900. No. 33100 A.

Prices.

Differential versus Uniform Prices for Gas. Sedgwick Dean. Read before the Michigan Gas Assn. Reviews the claims of the systems. 2000 w. Pro Age—March 1, 1900. No. 32785.

Retorts.

Oven and Retort House Construction and Results. Discussion at meeting of the New England Assn. of Gas Engs. 7000 w. Am Gas Lgt Jour—March 12, 1900. No. 32951.

Retort-Settings in 1850 and 1900. A drawing of the Crosthwaite system of 1850, for the setting of three retorts, with editorial. 2200 w. Jour Gas Lgt—March 13, 1900. No. 33102 A.

Standards.

Some Fantastic Standards of Light. Résumé of paper by J. E. Petavel. An account of investigations made. 2000 w. Jour Gas Lgt—Feb. 20, 1900. No. 32820 A.

MARINE AND NAVAL ENGINEERING

Battleship.

Contract Trial of the United States Battleship "Kentucky." Harrie Webster. Illustrated description of the vessel and its equipment, with report of trial. 3800 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32990 H.

H. M. Torpedo-Boat Destroyer "Viper," with Parsons Turbines. Brief illustrated description. 500 w. Engng—Feb. 16, 1900. No. 32791 A.

The Evolution of Battle-Ship Construction (Note sur l'Evolution de la Construction des Navires de Combat). L. de Chasseloup-Laubat. A general examination of the work of various nations, with especial reference to the later vessels of the French navy. 4500 w. Mem Soc Ing Civ de France—Feb., 1900. No. 33292 G.

The New Brazilian Armorclad "Marshall Deodoro." C. Field. Brief description, with illustration. 500 w. Sci Am—March 24, 1900. No. 33095.

The New French Battleship "Suffern" and Her Predecessor. C. Field. Brief illustrated description. 500 w. Sci Am—March 24, 1900. No. 33094.

Cargo-Boats.

Twenty Years of Progress in Cargo-Boat Machinery. J. F. Walliker. Read before the Inst. of Marine Engs. at

Stratford. Discusses the subject of boilers principally, referring briefly to other machinery. 3000 w. Prac Engr—March 9, 1900. No. 33039 A.

Coal Handling.

Emptying Coal Boats. Jenner G. Marshall. Read before the Assn. of Mech. Engs., Birmingham, Eng. Describes methods of handling coal, taking it from the vessel and depositing it some distance. 2800 w. Col Guard—March 9, 1900. No. 33035 A.

Compass.

The Evoy Compass. Illustrates and describes a compass so constructed as to enable it to be hoisted aloft to remove it from the effects of magnetic material, and enable its reading to be correctly taken on the bridge or deck. 500 w. Engr, Lond—Feb. 16, 1900. No. 32800 A.

Cruiser.

Our Latest Protected Cruiser, the "Albany." Illustrated description of an English-built cruiser purchased by the U. S. at the opening of the Spanish War, and but recently completed. 1400 w. Sci Am—March 10, 1900. No. 32926.

Dock Equipment.

Dock Equipment for the Rapid Handling of Coal and Ore on the Great American Lakes. Arthur C. Johnston. Illustrates and describes the special types of machinery built for the purpose of insuring quick dispatch in loading and unloading the ore and coal. 4500 w. Jour Assn of Engng Socs—Jan., 1900. No. 32833 C.

Disinfecting.

Disinfecting Steamer "Sanator" for the U. S. Marine Hospital Service. C. M. Green. Illustrated detailed description of a floating disinfecting plant. 4800 w. Marine Engng—March, 1900. No. 32916 C.

Forced Draft.

Limits to the Use of Forced Draft for Marine Boilers. Walter M. McFarland. A discussion of naval study and experiment in economy of space and evaporation, showing the advantages and limitations of forced draft in marine service. 4000 w. Engineering Magazine—April, 1900. No. 33298 B.

Germany.

The New Naval Bill (Aus der Novelle zum Flottengesetz). A tabulated description of the vessels included in the bill, with a schedule of the construction work allotted to each year. 2500 w. Glaser's Annalen—Feb. 15, 1900. No. 33252 D.

Ice Breakers.

Ice Breaking Vessels (Les Navires Brise-Glace). M. Hachebet. A description of the Russian ice-breaking vessel "Ermack," with photographs of the boat in service, breaking a channel through heavy ice. 2500 w. Génie Civil—Feb. 24, 1900. No. 33204 D.

Lightship.

Steam Electric Lightship for Cape Hatteras. Illustrated description. 1200 w. Sci Am—March 17, 1900. No. 33008.

Merchant Marine.

The American Merchant Marine. Winthrop L. Marvin. Reviews the history of American ship owning, discussing the causes, and steamship subsidies and the Frye bill. 6000 w. Rev of Revs—March, 1900. No. 33059 C.

Navigation.

Notable Incidents in Early Ocean Steam Navigation. Part first gives a brief account of the first iron steamship, the "Great Britain," how she came to be built, and the disaster that overtook her. Ill. 5000 w. Engr, Lond—March 16, 1900. Serial. 1st part. No. 33148 A.

Navy Yard.

New York Navy Yard, Brooklyn. Gives briefly the history of this yard, describing the buildings and various departments, and the proposed improvements. Ill. 2700 w. Sci Am—March 3, 1900. No. 32756.

Pacific Lines.

Steamship Lines of the Pacific Coast—Present Facilities and Probable Future Growth. D. S. Kimball. An account of the principal companies and illustrations of vessels. 3200 w. Marine Engng—March, 1900. No. 32913 C.

Propulsion.

On the Mechanical Theory of Steamship Propulsion. Robert Mansel. An account of investigations, giving results and discussing the subject generally. 3000 w. Engr, Lond—March 9, 1900. No. 33028 A.

Review.

A Retrospect and the Outlook on Marine Engineering. Waldon Fawcett. A review of the development, presenting many facts of interest. 3000 w. Ir Age—March 29, 1900. No. 33180.

River Boats.

Boats on the Volga (Schiffe auf der Wolga). R. Wels. Illustrating and describing the shallow draft steamers for Russian river service, especially the tank vessels for the transport of petroleum and naphtha. 3000 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33224 D.

Russia.

Merchant Marine of Russia. Information relating to the number of vessels and their location on different seas, size, ap-

pointment, etc. 1000 w. U. S. Cons Repts, No. 682—March 20, 1900. No. 33054 D.

Russian Mercantile Marine. Editorial review of points in the last report of the Acting-Consul of Odessa. 1500 w. Engng—March 9, 1900. No. 33027 A.

Screws.

The Theory of Propulsive Screws (Théorie des Helices Propulsives). M. Ratedie. A communication to the French Academy, reviewing the theory of Drzewiecki, in which the surface of each blade of a propeller is decomposed into its elements in order to enable its action to be investigated. 1200 w. Comptes Rendus—Feb. 19, 1900. No. 33231 D.

Sheathing.

Notes on Sheathing U. S. Naval Academy Practice Ship "Chesapeake." Lloyd Bankson. Read at New York meeting of the Soc. of Nav. Archts. and Marine Engs. Illustrates and describes the process of sheathing. 2000 w. Marine Engng—March, 1900. No. 32914 C.

Sheathing of Ships. Concerning the discussion of the naval board of construction as to whether the new vessels of the U. S. navy shall or shall not be sheathed. 3000 w. Marine Rev—March 22, 1900. No. 33136.

Shipbuilding.

Shipbuilding in England and Germany. Translation of a German newspaper clipping, giving reports for 1898 and 1899. 700 w. U. S. Cons Repts, No. 671—March 7, 1900. No. 32871 D.

Steam Turbine.

See Mechanical Engineering, Steam Engineering.

Steamer.

A Magnificent Inland Steamer. Description of the "Augusta," just completed for service on Chesapeake Bay. 1800 w. Naut Gaz—March 1, 1900. No. 32773.

Steering.

An Improved Form of Equilibrium Steering Gear (Nouveau Type de Gouvernail Equilibré). A description of the Joessel steering gear, in which a geared tumbling bob is used to counteract the lateral pressure upon the rudder. 1200 w. Génie Civil—Feb. 24, 1900. No. 33207 D.

Subsidies.

The Policy of Steamship Subsidies. Arthur T. Hadley. An argument against steamship subsidies as a means of relieving congested public treasuries, reprinted from a work printed in 1888. 4000 w. Rev of Revs—March, 1900. No. 33060 C.

Torpedo-Boat.

Progressive Trials of the Italian Torpedo Boat "Condor." From *Revista Marittima*. Brief description of vessel, with report of trials. 1500 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32992 H.

Torpedo Practice.

Torpedo Practice at Newport, R. I. Instantaneous photograph of discharge, with description. 700 w. Sci Am—March 10, 1900. No. 32925.

Tugs.

New Steel Screw Transfer Tugs for the N. Y., N. H. & H. Railroad Co. Illustrated detailed description of interesting examples of this type. 2500 w. Marine Engng—March, 1900. No. 32915 C.

Warships.

The Classification of Warships. Fred. T. Jane. Comparative tables of the warships of England, France, Germany, and Russia, with explanatory notes of interest. 3800 w. Engr, Lond—March 9, 1900. No. 33030 A.

Water-Tube.

See Mechanical Engineering, Steam Engineering.

Yacht.

Palatial Steam Yacht. Description of the "Dreamer," just completed for T. W. Lawson, by Lewis Nixon. 1800 w. Naut Gaz—March 8, 1900. No. 32944.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Accumulators. Félicien Michotte. An illustrated explanation of the apparatus and its working. 2800 w. Auto Mag—March, 1900. No. 32865 C.

Carburettor.

The Longuemare Petroleum (Heavy Oil) Carburettor. Illustrated description of the improved apparatus. 500 w. Automotor Jour—March, 1900. No. 33155 A.

City Vehicles.

The Street Car of the Future. Waldon Fawcett. Considers the automobile in its relation to electric lines in the city and suburbs, in parks and boulevards, etc. Ill. 2000 w. Auto Mag—March, 1900. No. 32863 C.

Coils.

Induction Coils. H. E. Wimperis. An illustrated account of the construction and working. 900 w. Automotor Jour—March, 1900. Serial. 1st part. No. 33156 A.

Combination Carriage.

The Pieper Combination Carriage. Illustrated description of a vehicle fitted with both a gasoline motor and a storage battery electric motor. 500 w. Horseless Age—March 7, 1900. No. 32947.

Compressed Air.

A Compressed Air Automobile (Une Automobile à Air Comprimé). Daniel Bellet. A description of the Molas, Lamielle and Tessier vehicle, with details of the compressed air motor and differential gearing. 3000 w. Revue Technique—Feb. 10, 1900. No. 33212 D.

Electric Cab.

Working Drawings of an Electric Cab. Gives drawings illustrating the design of the side elevation and mechanical features. 2200 w. Sci Am Sup—March 10, 1900. No. 32929.

Electromobile.

The Draulette Electromobile. Illustrated description of a cab differing in general appearance and driving mechanism from other electric vehicles. 1000 w. Auto Mag—March, 1900. No. 32864 C.

Motors.

Motors for Electric Automobiles. P. M. Heldt. Describes various innovations in this line, and discusses the problems. Ill. 2000 w. Elec Wld & Engr—March 10, 1900. No. 32970.

Motor Trials.

French Motor Trials. An account of the series of trials carried out in Paris to determine the actual power of motors as fitted to automobile vehicles, with tabulated results. 1400 w. Automotor Jour—Feb., 1900. No. 32815 A.

Motor Vehicles.

Automobiles Up-to-Date. From *The Blacksmith and Wheelwright.* Discusses the degree of success attained by the motor vehicle of to-day, claiming there is not yet a perfectly successful or reliable automobile. 4000 w. Am Mfr & Ir Wld—March 22, 1900. No. 33113.

The Hon. Evelyn Ellis's Motor Vehicles. An interesting series of photographs of various vehicles, with brief descriptions. 400 w. Automotor Jour—March, 1900. No. 33157 A.

Petroleum.

The "Mees" Petromobile. An illustrated account of the system introduced by Gustav Mees, noting the novel and interesting features. 3000 w. Automotor Jour—March, 1900. No. 33158 A.

Racing.

Automobile Club Racing. A copy of the rules and regulations of the Automobile Club of Great Britain and Ireland. 5000 w. Automotor Jour—March, 1900. No. 33160 A.

Rear Driving.

Effect of Rear Driving to Roughen the Road for the Automobile. M. C. Krarup. Discusses the effects of rear driving and its drawbacks. 1800 w. Am Mach—March 8, 1900. No. 32910.

Report.

Report on Motor Vehicles for Municipal Purposes. T. W. E. Higgens. Report presented to Chelsea Vestry on the various vans inspected. 1600 w. Automotor Jour—March, 1900. No. 33159 A.

Steam Wagons.

The Ideal Automobile. William Howard Paine. Considers the advantages and disadvantages of several types of carriages now in use, favoring the steam vehicles. 1700 w. Mod Mach—March, 1900. No. 32844.

Thornycroft Works.

The Thornycroft Steam Wagon Company. An illustrated account of the works and some of the vehicles. 2500 w. Automotor Jour—Feb., 1900. No. 32814 A.

Tires.

Automobile Tires. H. Falconnet. Illustrated description of such systems as have proven practicable, with the advantages of each. 2200 w. Auto Mag—March, 1900. No. 32866 C.

Traction Engines.

War Automobiles. From *La Nature.* Illustrations and particulars concerning the advantages of traction engines. 700 w. Sci Am Sup—March 10, 1900. No. 32928.

Trolley.

Automobile Trolley for Use on Highways (Trolley Automoteur pour les Transports Automobiles sur Routes). Ch. Dantin. An illustrated description of the Lombard-Gerin system, using an electrically propelled trolley and overhead wires for motor vehicles. 2500 w. Génie Civil—Feb. 10, 1900. No. 33200 D.

Distribution by Wire for Electric Traction on Roads (Application de la Distribution par Fils à la Traction Electrique sur Routes). N. de Tedesco. The Lombard-Gerin system enables electric vehicles to obtain current from overhead wires, by means of an automatic trolley. 2000 w. Revue Technique—Feb. 25, 1900. No. 33215 D.

Self-Moving Road Vehicles with Automobile Double Trolleys. E. Hospitalier, in *L'Industrie Electrique.* Illustrated de-

scription of an automobile trolley, designed by M. Lombard-Gerin. 800 w. Elec Rev, N. Y.—March 7, 1900. No. 32948.

Weight.

The Weight of Motor Wagons. Editorial discussion of the British Light Locomotives Act of 1896. 3000 w. Engng—March 16, 1900. No. 33145 A.

Wheels.

Dished Wheels. H. E. Wimperis. Considers their advantages and disadvantages when applied to motor cars. 1200 w. Automotor Jour—Feb., 1900. No. 32816 A.

HYDRAULICS.

Pumping Engines.

The Old and New Pumping Engines of Dry Dock No. 1, Brooklyn Navy Yard. Illustrated description, showing the advance made in this class of machinery. 1500 w. Sci Am—March 24, 1900. No. 33096.

Water Lifts.

Installation of Water Lifts. Illustrated description of four systems of installing water lifts. 1000 w. Dom Engng—March 15,. 1900. No. 33067 C.

Water Power.

The New Water Power of the Hartford Electric Light Company. W. L. Robb. Illustrated detailed description. 1500 w. Am Elect'n—March, 1900. No. 32855.

MACHINE WORKS AND FOUNDRIES.

Analysis.

Analysis in the Foundry. Stuart B. Marshall. Discusses various elements and their effects, and considers chemical analysis the only true selling guide. 1800 w. Ir Trd Rev—March 15, 1900. No. 33013.

Armory.

The United States Armory at Springfield, Mass. D. E. MacCarthy and F. J. M. Illustrated description of the oldest and most famous of the U. S. workshops and the manufacture of the army magazine rifle, known as the Krag-Jorgensen. 2500 w. Am Mach—March 22, 1900. Serial. 1st part. No. 33105.

Bearings.

On Antimonial Alloys for Axle Bearings. H. Behrens and H. Baucke. An account of chemical and microscopic examination of several cushions of Babbit metal with a view of ascertaining the causes leading to hot boxes. 3000 w. Metallographist—Jan., 1900. No. 32826 E.

White Metal or Gunmetal for Bearings. W. H. Booth. Discusses the conditions that have caused the more extensive use of white metal in America than in England, and the importance of the best lubrication obtainable. 800 w. Am Mach—March 1, 1900. No. 32748.

Blue-Printing.

A Novel and Convenient Blue-printing Gallery. Illustrates and describes the arrangements at the works of the Brown Hoisting and Conveying Machine Co., of Cleveland, Ohio. 600 w. Am Mach—March 29, 1900. No. 33185.

Castings.

A Casting With a Troublesome Core. R. H. Palmer. Illustrates and describes the casting of a drying machine column. 900 w. Am Mach—March 15, 1900. No. 32999.

Cast Iron.

Annealing Malleable Cast Iron. George C. Davis. Prepared for the Foundrymen's Assn. Also discussion by Dr. Richard Moldenke. On the changes resulting from annealing, with experiments. 3000 w. Ir Trd Rev—March 8, 1900. No. 32911.

Compasses.

Compass for Drawing Arcs of Large Radius. Ulrich Peters. Illustrates and describes a system of link connections. 800 w. Am Mach—March 22, 1900. No. 33106.

Cores.

Judgment in the Use of Cores. R. H. Palmer. Suggestions for the making and setting of cores. 1300 w. Am Mach—March 8, 1900. No. 32907.

Design.

The Genesis of Machine Design, with Applications. W. H. Sargent. An illustrated article presenting some suggestions showing the influence of natural forms, and discussing shop designing. 2300 w. Mach, N. Y.—March, 1900. No. 32852.

Draughting.

Draughting Department, Union Iron Works. Illustrated description of the special drafting building, furniture and methods of management in a San Francisco ship and machinery building establishment, where the designing is particularly difficult because of the distance of the plant from the sources of supply in the Eastern States. 3000 w. Eng Rec—March 10, 1900. No. 32963.

The New Drafting Room of the Brown & Sharpe Manufacturing Company. L. D. Burlingame. Illustrated detailed description of a finely equipped room. 2000 w. Am Mach—March 8, 1900. No. 32908.

Drill Grinder.

A Constantly Adjusted Twist Drill Grinder. Illustrated detailed description.

700 w. Am Mach—March 1, 1900. No. 32749.

Engine Frame.

Two Ways of Machining an Engine Frame. B. W. T. Illustrates and describes the methods. 1800 w. Am Mach—March 29, 1900. No. 33184.

Foundry Irons.

Foundry Irons. Edward Kirk. Short descriptions of the various irons, their characteristics and uses. 4500 w. Foundry—March, 1900. No. 32832.

Gear Teeth.

Cutting Wheels With Prime Numbers of Teeth. Richard Inwards, in the *English Mechanic and World of Science*. Illustrates and describes the method. 900 w. Prac Engr—Feb. 23, 1900. No. 32886 A.

New Forms for Gear Teeth (Neuere Zahnformen). G. Lindner. Especially discussing the effect of shortening the points of the teeth to avoid undercutting of low numbered pinions. The special forms of rack and pinion teeth for rack railways are also discussed. 5000 w. Zeitschr d Ver Deutscher Ing—March 10, 1900. No. 33228 D.

The Geometrical Generation of Irregular Surfaces in Machine Construction. Henry Roland. Giving the history and practice of the modern method of producing theoretically correct tooth forms by the movement of the surfaces. 3000 w. Engineering Magazine—April, 1900. No. 33299 B.

Interchangeability.

Interchangeability of Units in Machinery. W. D. Forbes. On the value of the interchangeable unit, and the advantages. 1200 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32994 H.

Iron Works.

The Works and Operations of Palmer's Shipbuilding and Iron Company. Illustrates and describes principally the foundries and blast-furnaces, and methods of manufacture of pig iron and steel. 2400 w. Ir & Coal Trds Rev—Feb. 16, 1900. No. 32802 A.

Living Force.

A Simple Method of Measuring Living Force (Ein Einfaches Verfahren zur Messung Lebendiger Kräfte). H. Heim. The force of the blow of a hammer or other falling mass is permitted to crush a cylinder of lead, the magnitude of the force being computed by the extent of the deformation of the lead. 1800 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33226 D.

Lubricants.

Air as a Lubricant. Herman S. Heichert. From the *Rose Technic*. Describes experiments being made at the Worcester Polytechnic Inst., with a machine designed by Albert Kingsbury. Ill. 1000 w. Eng News—March 8, 1900. No. 32939.

Experiments With an Air-Lubricated Journal. Albert Kingsbury. Describes the apparatus used and gives experimental results. Ill. 5000 w. Jour of Worcester Poly Inst—March, 1900. No. 33021 C.

Machinery.

A Comparison Between Hand and Machine Work (Comparaison du Travail à la Main et du Travail à la Machine). M. E. Levasseur. An exhaustive examination of the influence of machinery upon industry, with numerous historical and official references. Serial, Part I. 12000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33240 G.

Milling Machines.

One of the Earliest Milling Machines. E. G. Parkhurst. Illustrates and describes a primitive hand milling machine made in 1818. 800 w. Am Mach—March 8, 1900. No. 32906.

Molding.

Molding a Propeller Wheel in Green Sand. R. H. Palmer. Shows a way of molding a propeller wheel of four blades from a pattern of one blade. Ill. 900 w. Am Mach—March 1, 1900. No. 32747.

Patterns.

Pattern Making—Using Loose Pieces Instead of a Core. John M. Richardson. Illustrated description, showing how loose pieces can be used to advantage. 600 w. Am Mach—March 22, 1900. No. 33108.

Pipe Threads.

The Unification of Pipe Threads (Unification des Filetages sur Tubes). A communication from the Royal Institute of Engineers of the Netherlands urging united action to secure uniformity, and providing blank forms for replies. 1000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33243 G.

Pneumatic Tools.

Portable Pneumatic Tools. Ewart C. Amos. Read before the Inst. of Mech. Engs. Describes the mechanism for utilizing compressed air, and the various tools to which it is applied. Ill. 3700 w. Engng—March 2, 1900. Serial. 1st part. No. 32975 A.

Power-Hammer.

The Longworth Power-Hammer. Ernest Samuelson. Read before the Inst. of Mech. Engs. Drawings illustrating improvements made, with description. 2200 w. Engng—March 2, 1900. No. 32974 A.

Rearrangement.

Locating Tools in a Reconstructed Shop. A description of the location of tools and the appliances for handling and machining the various parts of engines. 1100 w. Am Mach—March 1, 1900. No. 32750.

Seamless Tubes.

A Machine for Drawing Seamless Steel Tubes with Longitudinal Ribs. Illustrated description of the methods of manufacture, and statement of advantages claimed. 1200 w. Eng News—March 1, 1900. No. 32765.

Shrinkage.

Shrinkage and Disintegration of Metals. W. Roxburgh. Remarks on the relation of the two terms used, with the opinion that shrinkage must be recognized as the cause of disintegration. 1400 w. Foundry—March, 1900. No. 32831.

Tool Holder.

A Gang Tool Holder for the Planer. Illustrates a design for such a tool, and remarks on its use. 400 w. Am Mach—March 22, 1900. No. 33107.

Tools.

American Machine Tools. Information concerning shop practice, with illustrated detailed descriptions of many of the tools. 2700 w. Engr, Lond—Feb. 16, 1900. Serial. 1st part. No. 32798 A.

Liquid Operated Machine Tools. F. Thornely. Illustrated description of a hydraulic vertical planer, and of a proposed water motor system. 400 w. Am Mach—March 15, 1900. No. 33000.

Tubes.

The Manufacture of Seamless Tubing (Verfahren zur Herstellung von Nahtlosen Hohlkörpern). H. Zobler. A description of the Erhardt process, by which a steel mandrel is pressed through the solid blank, which is afterwards drawn. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1900. No. 33218 D.

MATERIALS OF CONSTRUCTION.

Buckling.

Investigations Into the Buckling of Piston Rods (Untersuchung der Knickfestigkeit von Kolbenstangen). G. Huguenin. A mathematical investigation of the forces and their action upon a piston rod in a steam engine, with diagrams deduced from the equations. A practical example is given. 1800 w. Schweizerische Bauzeitung—March 3, 1900. No. 33247 B.

Rubber.

A Study of Rubber Production in the Soudan (Etude sur le Caoutchouc au Soudan). M. Hamet. An abstract of the report of the French scientific commission, showing the adaptability of the Landolphia Hendolotti for cultivation in the Soudan. 3000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33242 G.

Tanks.

Calculations for Sheet-Iron Tanks (Calculs de Réservoirs en Tôle). Maurice Koechlin. A mathematical discussion of the computation of the forms of tanks, so that the stresses in the bottom shall neutralize each other. The method of Professor Intze is employed. 2500 w. Génie Civil—March 3, 1900. No. 33209 D.

POWER AND TRANSMISSION.

Air-Compressors.

Hints Concerning Air-Compressors. H. H. Kelley. Illustrates and describes the construction and operation. 2200 w. Engr, U. S. A.—March 1, 1900. No. 32905.

Air Propellers.

The Lifting Power of Air Propellers. William George Walker. Illustrated description of experiments on the thrust or lifting power of air propellers 30 feet in diameter. 2500 w. Engng—Feb. 16, 1900. No. 32796 A.

Belts.

Length of Belts. A demonstration of the ways of solving the problem. 1200 w. Prac Engr—Feb. 16, 1900. No. 32803 A.

Hospital Plant.

Light, Heat and Power at the Kankakee Hospital. Illustrated description of a new plant recently installed. 2000 w. W Elect'n—March 3, 1900. No. 32854.

Linkages.

Straight Line Motions. From a paper by John B. Peddle in *The Rose Technic*. Illustrates and describes various classes. 1800 w. Am Mach—March 15, 1900. No. 32998.

Pneumatic Despatch.

Pneumatic Despatch. C. A. Carus-Wilson. Gives an illustrated description of various means tried in London for conveying the mails, and discusses the pneumatic tube circuits now in use in various places. Discussion. 6600 w. Jour Soc of Arts—March 2, 1900. No. 32973 A.

Ropes.

Hoisting Ropes. Robert Peele. Considers the various kinds in use and the properties which influence their strength and life. 4200 w. Mines & Min—March, 1900. No. 32780 C.

Variable-Speed.

A Variable-Speed Power Transmission Apparatus. Illustrated description of the Reeves device. 500 w. Eng News—March 1, 1900. No. 32767.

SPECIAL MOTORS.

Gas Engines.

Large Gas Engines (Grosse Gasmaschinen). E. Meyer. A discussion of the development of the large gas engine, with especial reference to the use of producer and furnace gases, with illustrations of recent designs. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 10, 1900. No. 33227 D.

Gasoline.

The Gasoline Engine. H. S. Pell. Read before Toronto No. 1 Canadian Assn. of Stationary Engs. Discusses the main features of the gasoline engine, the characteristics of the fuel, etc. 3800 w. Can Elec News—March, 1900. No. 33019.

Gas Power.

Gas Engines and Electricity Supply Stations. Alton D. Adams. A careful presentation of the advantages possessed by gas as a means of transmission of energy, in connection with gas engines at the electric generating stations. 3000 w. Engineering Magazine—April, 1900. No. 33295 B.

Motor Trials.

See Automobilism.

Petroleum.

See Automobilism.

Turbine.

The Utilization of Heat in the Hot-Air Turbine (Wärmeausnutzung der Heizluftturbinen). V. Lorenc. A mathematical discussion of motors of the class in which the heated gases of combustion are projected against an impact turbine, showing that no higher thermal efficiency can be expected than has already been attained with the steam engine. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1900. No. 33223 D.

Water Motors.

The Construction of Small Water Motors. P. Pitman. Explanation of the principles underlying the action of water-motors, and the application of those principles to their design and construction on a small scale. Ill. 2000 w. Elec, Lond—March 9, 1900. Serial. 1st part. No. 33097 A.

STEAM ENGINEERING.

Boiler Accident.

A Remarkable Boiler Accident. W. F. Durand. Describes an accident to a boiler on a tug-boat in N. Y. harbor, which caused the complete melting of a mass of wrought iron boiler tubes, with no explosion. Also suggestions of a possible solution. Ill. 1400 w. Sib Jour of Engng—March, 1900. No. 33175 C.

Boiler Feeders.

Selecting a Boiler Feeder. W. H. Wakeman. Presents the advantages and disadvantages of pumps and injectors. 2400 w. Mod Mach—March, 1900. No. 32845.

Chimneys.

The Monumental Chimneys of the Champ-de-Mars (Cheminées Monumentales du Champ-de-Mars). E. Cayla and P. Lerolle. Giving illustrations of the two great chimneys of the Paris Exposition, and the full detailed calculations of the draft, with comparisons of other large chimneys. 4000 w. 1 plate. Génie Civil—Feb. 10, 1900. No. 33201 D.

Distilling Plant.

Report of a Six-Day Trial of the "Lillie" Multiple-Effect Distilling Plant at Dry Tortugas, January 13 to 20, 1900. R. K. Crank. Describes the methods and plant, giving results of the test, and other information of interest. Ill. 3700 w. Jour Am Soc of Naval Engs—Feb., 1900. No. 32993 H.

Engines.

Relative Efficiency and Desirability of Various Types of Engines on Central Station Loads. A. W. Richter. Abstract of a paper read before the Northwestern Electrical Assn. Discusses various types, and the points to be considered in connection with the local conditions in choosing an economical outfit. 3000 w. St Ry Rev—March 15, 1900. No. 33005 C.

The Politics of the Steam Engine. Fred W. Lehmann. Discusses the influence the steam engine has had in the development of national life in the United States. 6300 w. Pro St. Louis Ry Club—March 9, 1900. No. 33181.

Feed Water.

Feed Water Purification. Methods for separating the salts from water as received from rivers and wells. Ill. 1800 w. Am Elect'n—March, 1900. No. 32862.

The Work of Railroad Men on the Problem of Pure Water for Steam Boilers. C. Herschel Koyl. Part first reviews the valuable statistics gathered by the Master Mechs.' Assn. in their investigations of boiler water. 1700 w. R R Gaz—March 23, 1900. No. 33110.

Firing.

Firing. H. H. Kelley. Suggestions for changing the methods of firing to suit the conditions. Ill. 2500 w. Engr, U. S. A.—March 15, 1900. No. 33080.

Steam Turbines.

Steam Turbines and High-Speed Vessels. Charles A. Parsons. Abstract of the Presidential Address to the Inst. of Jun. Engs. Considers the applications of

the steam turbines and the advantages. Ill. 3000 w. Ap Pop Sci M—April, 1900. No. 33178 C.

Motive Power. Steam Turbines. High Speed Navigation. C. A. Parsons. A discourse delivered at the Royal Inst. An account of the progress of the steam turbine and its applications and advantages. 6000 w. Nature—March 1, 1900. No. 32946 A.

The Westinghouse-Parsons Steam Turbine. Describes and illustrates the turbines recently installed in the power plant of the Westinghouse Air Brake Co., at Wilmerding, Pa. 2300 w. Am Engr & R R Jour—March, 1900. No. 32759 C.

Thermodynamics.

An Experimental Investigation of the Thermodynamical Properties of Superheated Steam. John H. Grindley. Investigates the law of flow of saturated steam through small orifices, and the cooling by free expansion, and other properties. 2500 w. Engr, Lond—March 16, 1900. No. 33153 A.

Valve Gear.

See Railway Affairs, Motive Power.

Waste Heat.

Utilization of Waste Heat. Editorial discussion of the steam engine and steam boiler in this connection. 2000 w. Engr, Lond—Feb. 23, 1900. No. 32877 A.

Water-Tube.

Practical Data Relating to the Building of Bent-Tube Boilers. John Platt. A general description of the plan adopted in laying out and building one of these boilers. Ill. 3500 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32991 H.

Water-Tube Boiler (Générateur à Vapeur Aquitubulaire). A description of the Turgan boiler; inclined Field tubes are used, connected to a central steam and water drum overhead. 1500 w. Revue Technique—Feb. 25, 1900. No. 33217 D.

MISCELLANY.

Aeronautics.

The Navigation of the Air (La Navigation Aerienne). R. Soreau. A discussion of the influence of the wind near the surface and at an elevation, as a preliminary to the study of aërial navigation. 2000 w. Génie Civil—Feb. 24, 1900. No. 33206 D.

Artillery.

Modern Field Artillery. Illustrations of modern field guns, their carriages and equipments, with descriptions. 3500 w. Engng—March 2, 1900. Serial. 1st part. No. 32978 A.

Education.

Technical Education—An Economic Necessity. V. M. Alderson. Extracts from an address before the Central Ry. Club. 3500 w. Am Mach—March 29, 1900. No. 33183.

Indexing.

Decimal Indexes of Mechanical Literature. Illustrated letter, from Albert B. Herrick, describing a combination of decimal indexing and filing methods, found useful for many specialties. 1000 w. Eng Rec—March 10, 1900. No. 32967.

Industries.

Economic and Labour Factors in the Distribution of Industries. John Richards. A discussion of the effects of trusts and protection as opposed to the laws of industrial evolution. 3500 w. Engineering Magazine—April, 1900. No. 33300 B.

Laboratory.

The Engineering Laboratory of the Technical High School at Hanover (Das Ingenieurlaboratorium der Königlichen Hochschule zu Hannover). F. Frese. A very full account of this completely equipped mechanical laboratory, with plans of the buildings, and illustrations of apparatus. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 24, 1900. No. 33219 each D.

Liquid Air.

Facts versus Claims for Liquid Air. Hudson Maxim. Considers some of the claims, and the applications in which it is most likely to be of value. 2400 w. Sci Am—March 17, 1900. No. 33007.

Linde Liquid Air Machine at the University of Michigan. Alfred L. Davenport. Illustrated description of a machine recently added to the scientific apparatus of the university. 700 w. Eng News—March 8, 1900. No. 32936.

Liquid Air as an Explosive. An account of experiments at Vienna, with the conclusions. 700 w. U. S. Cons Rpts. No. 673—March 9, 1900. No. 32896 D.

Liquid Atmospheric Air (Ueber Flüssige Atmosphärische Luft). Franz Walter. A general account of the method of producing liquid air, and a description of the phenomena of intense cold produced by it. Its practical applications are stated to be limited. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 9, 1900. No. 33238 each B.

Prof. Pictet's Experiments With Liquid Air. Illustrated description of experiments with liquid air and the separation into its constituents, by which these gases are obtained in large quantities at low cost. 2200 w. Sci Am—March 31, 1900. No. 33367.

MINING AND METALLURGY

COAL AND COKE.

Bear Island.

The Coal Deposits of Bear Island (Die Kohlenlager der Bäreninsel). H. Möllman. A brief account of the important coal deposits of the island, which lies in the Arctic ocean between Norway and Spitzbergen. 1200 w. Glückauf—March 10, 1900. No. 33266 B.

Cape Breton.

Notes on the Deposition and Development of the Glace Bay Coal Seams. S. F. Kirkpatrick. From a paper read before the Applied Science Soc. of McGill Univ. Describes the deposits and method of mining. 2000 w. Can Engr—March, 1900. No. 33001.

Coal Resources.

Our Coal Resources and Consumption —A Reconsideration of Some Estimates. Considers the question of the quantity of coal in Great Britain, examining information given by Profs. Edward Hull and Stanley Jevous. 2000 w. Jour Gas Lgt —Feb. 20, 1900. Serial. 1st part. No. 32821 A.

Coke Making.

Time in Coke Making. William Gilbert Irwin. Brief account of experiments along this line. 900 w. Eng & Min Jour—March 3, 1900. No. 32850.

Connellsville.

Development of the Connellsville Coke Region. W. G. Irwin. A brief historical account of the industry. 1100 w. Eng & Min Jour—March 24, 1900. No 33135.

Face Mining.

Mining Coal at the Face. J. T. Beard. Points in regard to working which must be carefully considered to secure economy and safety. Ill. 4500 w. Mines & Min—March, 1900. No. 32781 C.

Lievin Colliery.

Continuation of the Pas-de-Calais Coalfield. M. A. Simon. From a communication to the Soc. Ind. Min. An illustrated account of exploring works recently carried out with the object of proving that the coal measures extend beyond the conceded portion and at a depth that can be reached by present methods of working. 3000 w. Col Guard—Feb. 16, 1900. No. 32788 A.

Limburg.

The Hard-Coal Basins in the Holland Province of Limburg (Das Steinkohlenbecken in der Holländischen Provinz Limburg). Franz Büttgenbach. A brief description of the Limburg mines, and the influence which their development will have upon the German coal trade. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 17, 1900. No. 33258 B.

New South Wales.

Coal Mining in New South Wales. Harrison F. Bulman. Part first gives the history and geology, with maps. 1700 w. Col Guard—Feb. 23, 1900. Serial. 1st part. No. 32872 A.

New Zealand.

Coal on the Cape Colville Peninsula. Describes the deposits, which are of more interest from a geological than from an economic point of view. 2500 w. N Z Mines Rec—Jan. 16, 1900. No. 33024 B.

See Electricity, Electro Physics.

COPPER.

British Columbia.

Prospects on Howe Sound, West Coast. W. M. Brewer. Describes this property, examined by the writer, and states the conclusions. 1500 w. Eng & Min Jour—March 17, 1900. No. 33074.

Idaho.

The Seven Devils Mining District, Idaho. William Beals, Jr. An interesting description of these copper deposits. Ill. 3000 w. Eng & Min Jour—March 24, 1900. No. 33133.

Supply.

The World's Supply of Copper. Frederick H. Hatch. The second portion of Dr. Hatch's paper is devoted to the production of all the districts not included in the United States, Portugal, and Japan; these having been treated in the previous part. 6000 w. Engineering Magazine—April, 1900. No. 33297 B.

GOLD AND SILVER.

Africa.

Macombe's Country (South of the Zambesi), Its Ancient Goldfields and Industrial Resources. Dr. Carl Peters. Interesting descriptive account, with discussion. 6400 w. Jour Soc of Arts—March 9, 1900. No. 33098 A.

British Columbia.

Mining Development on Vancouver Island in 1899. W. M. Brewer. Report of work and results. 1200 w. Eng & Min Jour—March 10, 1900. No. 32923.

The Trout Lake District. R Leckie-Ewing. Information concerning the mineral possibilities of this section, with illustrations. The characteristic ore is argentiferous galena, with which is associated grey copper and gold. Other min-

erals are present also. 1600 w. B C Min Rec—March, 1900. No. 32917 C.

Van Anda, Texada Island, B. C. Illustrated description of the properties of the Van Anda Copper and Gold Company. 2400 w. Eng & Min Jour—March 3, 1900. No. 32851.

Butte.

Butte Mining District. Arthur Lakes. Its geology and history and a description of the various ores from which its output is derived. Ill. 2700 w. Mines & Min—March, 1900. No. 32779 C.

California.

Cheap Mining and Milling at the Spanish Mine. Horace F. Brown. An account of a California gold mine and its working of low-grade ore. Ill. 1500 w. Min & Sci Pr—March 24, 1900. No. 33188.

Cape Nome.

The Gold Sands of Cape Nome. Angelo Heilprin. An interesting account of this mining district, giving its history, and describing the deposits and workings. Ill. 3700 w. Ap Pop Sci M—April, 1900. No. 33176 C.

Concentrating Plants.

New Bunker Hill and Sullivan Mill. An illustrated description of how one of the largest concentrating plants was built in four months. 800 w. Mines & Min—March, 1900. No. 32778 C.

Custom Mill.

The Montana & Denver Reduction Company's Mill at Bearmouth, Montana. Fred D. Smith. An illustrated account of this mill and the conditions that led to its erection. 1800 w. Eng & Min Jour—March 24, 1900. No. 33134.

Dredging.

A Modern Dredger Mining Plant. Illustrates and describes dredgers the motors of which are operated by alternating current. 700 w. Min & Sci Pr—March 24, 1900. No. 33187.

Gold Dredging. R. H. Postlethwaite. Discusses the conditions it is necessary for a dredge to fulfill in order to operate successfully. 2200 w. Mines & Min—March, 1900. No. 32777 C.

Gold-Dredging in New Zealand, Victoria, and New South Wales. George Robson. Read before the New South Wales Chamber of Mines. Descriptive paper, with discussion. 3300 w. N Z Mines Rec—Jan. 16, 1900. No. 33025 B.

Precipitation.

Successful Precipitation from Solutions Weak in Cyanide. Matt W. Alderson. An account of successful precipitation with hardly more than a trace of cyanide. 2300 w. Min & Sci Pr—March 24, 1900. No. 33186.

Siliceous Ores.

Wet Crushing and Cyaniding the Siliceous Ores of the Black Hills, South Dakota. John M. Henton. Describes the practice and gives table showing the conditions of the solutions and the precipitation during the month of Jan., 1900. 1100 w. Min & Sci Pr—March 10, 1900. No. 33014.

Transvaal.

The Transvaal Mining Industry for the Second Half of 1899. An account of the conditions and operations of the mines, touching on the political phases only so far as necessary to explain their influence on the industry. Also editorial. 4800 w. Eng & Min Jour—March 10, 1900. Serial. 1st part. No. 32920.

Washington.

The Mountain Lion Mine, Republic, Washington. M. H. Joseph. Information of a valuable mine, with illustrations. 2000 w. Eng & Min Jour—March 10, 1900. No. 32921.

IRON AND STEEL.

Armor Plates.

Armor Plates for the United States Navy. Reviews the history of the conflict between Congress, the government officials, and the manufacturers, during the last thirteen years, as given by the Am. Ir. and Steel Assn. 6200 w. Engr Lond—March 16, 1900. No. 33147 A.

Blast Furnaces.

Comparison of American and British Blast Furnace Practice. T. B. Rogerson. Read before the West of Scotland Ir. and Steel Inst. Describes the methods of work in Scotland and the United States, and form a comparison. 4000 w. Col Guard—March 16, 1900. No. 33143 A.

Brown Ores.

Some Notes on the Brown Iron Ores of Georgia. S. W. McCallie. Illustrates and describes the deposits and manner of working. 1500 w. Eng & Min Jour—March 3, 1900. No. 32849.

Carburized Irons.

New Reagents for the Micrographic Study of Carburized Irons. F. Osmond and G. Cartraud. Gives results of investigations. 800 w. Metallographist—Jan., 1900. 32825 E.

Converter.

A Study of the Thomas Converter (Etude sur le Convertisseur Thomas). A. Spilberg. A general discussion of the form, dimensions and accessories of a 12 ton basic converter. 800 w. Rev Univ des Mines—Feb., 1900. No. 33289 G.

Foundry Irons.

See Mechanical Engineering, Machine Works and Foundries.

Furnaces.

Reverberatory Furnaces. R. H. Palmer. Considers two kinds of reverberatory furnaces, one using a blast, the other natural draft. Ill. 2700 w. Foundry—March, 1900. No. 32830.

Italy.

The Iron and Steel Industry of Italy. Interesting particulars in regard to the progress and development. 3000 w. Ir Age—March 15, 1900. No. 33006.

Iron Markets.

The Competitors for the World's Iron Markets in 1899. J. S. Jeans. A comparison of the exports of 1899 of Great Britain, Germany, France, Belgium, and the United States. 2500 w. Ir Age—March 29, 1900. No. 33179.

Iron Works.

See Mechanical Engineering, Machine Works and Foundries.

Nickel Steel.

On the Position of the Points of Magnetic Transformation of Nickel Steels. L. Dumas, in *Comptes Rendus.* An account of investigations carried on at the Impley Works. 700 w. Metallographist—Jan., 1900. No. 32829 E.

Progress.

Iron and Steel—British and American. Editorial comment on the particulars of the iron industry in the United States as compiled by J. M. Swank, making comparison with Great Britain. 3200 w. Engng—March 16, 1900. No. 33146 A.

The Growth of the Iron Industry in the United States. F. W. Taussig. Abstract of a paper in *The Quarterly Journal of Economics.* An outline of the factors that have influenced this industry and caused the almost marvelous development. 1500 w. Col Guard—March 16, 1900. No. 33142 A.

Steel.

The Manufacture of Steel on the Basic Open-Hearth. Thomas Turner. Read before the West of Scotland Ir. and Steel Inst. Gives suggestions of value in steel making, and some results obtained by the basic open-hearth process, considering the different stages of the practice. 2800 w. Col Guard—Feb. 16, 1900. Serial. 1st part. No. 32790 A.

Transformations.

On the Changes of State in Iron and Steel. H. Le Chatelier, in *Comptes Rendus.* A study of the transformations due to temperature changes. 800 w. Metallographist—Jan., 1900. No. 32828 E.

MINING.

Geology.

Geological Notes from Denver, Colorado, to El Paso, Texas. Illustrated description. 2500 w. Mines & Min—March, 1900. No. 32783 C.

Inclines.

Inclined Planes (Les Plans Inclines). H. Ghysen. A discussion of the essentials in the construction of inclined planes in mines with regard to safety, including friction brakes, safety appliances, etc. 2500 w. 1 plate. Rev Univ des Mines—Feb., 1900. No. 33290 G.

Mining Improvements.

Improvements in Hauling, Winding and Loading. After extracts by *Glückauf* from the official report, "Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen wahrend des Jahres 1898." Descriptive. 2500 w. Col Guard—Feb. 23, 1900. No. 32874 A.

Mine Power.

See Electrical Engineering, Power.

Mine Roads.

Mine Roads and Tracks. H. L. Auchmuty. The importance of good roads for securing economical handling of the mine products. The material, grades, weight of rail and size of ties, drainage, switches, curves, etc. 5000 w. Mines & Min—March, 1900. No. 32776 C.

Power.

Utilizing for Power the Descent of Gob Material. M. Berne. From a communication to the Société de l'Industrie Minérale. Describes the installation at the Saint-Etienne colleries, in which compressed air is used as a vehicle of the power. Ill. 3000 w. Col Guard—March 2, 1900. No. 32977 A.

Props.

Pit Props and Their Setting. J. Dickinson. Paper read before the Manchester Geol. Soc. On the strength of timber and setting of props, giving opinions of investigators, deductions and comparisons. 5000 w. Ir & Coal Trds Rev—Feb. 23, 1900. No. 32868 A.

Rope Haulage.

The Cost of Rope Haulage in Underground Workings (Die Betriebskosten der Unterirdischen Seilförderungen). An exhaustive review of the cost of rope haulage in the Ruhr district, as compared with animal power or electricity. 7500 w. 3 plates. Glückauf—Feb. 10, 1900. No. 33262 B.

Safety Door.

An Improved Safety Door for Mine Shafts (Ueber Einen Neuen Sicherheits-

Schachtsverschluss). The sliding door is operated automatically by levers actuated by the wheels of the car. 800 w. 1 plate. Glückauf—Feb. 24, 1900. No. 33264 B.

Safety Lamps.

Testing Interior Igniters for Safety Lamps. Bergassessor Balzer, in *Oesterreichische Zeitschrift für Berg Hütten und Salinenwesen.* Illustrates and describes experiments made to ascertain to what extent the lamps are liable to flare when lighted by percussion igniters in a fiery atmosphere, and so produce explosions. 1800 w. Col Guard—Feb. 16, 1900. No. 32789 A.

Shafts.

An Improvement in the Kind-Chandron Shaft-Sinking Apparatus (Ueber Neuerungen beim Kind-Chaudrouschen Abteufverfahren). With illustrations of an improved steel boring tool, and a suspended bucket dredge, as employed in sinking shafts in Belgium. 800 w. 1 plate. Oesterr Zeitschr f Berg u Hütten wesen—Feb. 24, 1900. No. 33260 B.

Improved Platform for Lining a Sinking Shaft. Plan and vertical section with description and statement of advantages. 1000 w. Col Guard—March 9, 1900. No. 33034 A.

Shafts and Shaft Machinery. A. S. Boucher. Read before the N. S. W. Chamber of Mines. Considers the kind of shaft, shape, size, and position, the timbering, equipment, etc. 3900 w. Aust Min Stand—Feb. 1, 1900. No. 32-904 B.

The Sinking of Shaft II. of the Osterfeld Mine (Das Abteufen des Schachtes II. der Zeche Osterfeld im Deckgebirge). A description of the method adopted in one of the coal mines in the Ruhr district near Oberhausen, in sinking a shaft through sand, gravel, and marl. 1000 w. Glückauf—Feb. 17, 1900. No. 33263 B.

Surveys.

Underground Surveys and Their Connection with the Surface by the Transit Method. E. H. Liveing. An illustrated description of a method particularly suited to deep shafts. 2200 w. Mines & Min—March, 1900. No. 32782 C.

Tipping.

A Tipping Device for Buckets (Eine Aussturzvorrichtung für Kästen in Führungen). A. Lukaszewski. Illustrating and describing an arrangement by which the tipping and emptying of a mine bucket is accomplished by pins seating in an inclined support. 800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 24, 1900.—No. 33259 B.

Tipping Arrangement for Kibbles Working in Guides. A. Lukaszewski. From *Zeitschrift für das Berg und Hüttenwesen.* Brief illustrated description of a contrivance used in a colliery in Hungary. 800 w. Ir & Coal Trds Rev—March 2, 1900. No. 32981 A.

Transport.

Wheel and Pack Transport for Mines. C. C. Longridge. Considers the systems of transport and the kind of transport, discussing the advantages under various conditions. 3000 w. Engr, Lond—March 9, 1900. No. 33029 A.

Under Sea.

Under-Sea Mining at Arnao, Spain. Alphonse Dory. From a communication to the Société des Ingenieurs des Mines du Hainaut. Describes the surface and underground works. Ill. 3000 w. Col Guard—March 16, 1900. No. 33141 A.

Ventilation.

Fan Speed and Pressure Recorders. Describes two appliances used at the Saint-Etienne collieries, which have given entire satisfaction. Ill. 1400 w. Col Guard—March 9, 1900. No. 33036 A.

Winding.

Winding from Deep Mines. Illustrates and describes the system introduced at Dolcoath mine by its inventor, William Morgans. 1600 w. Engr, Lond—March 16, 1900. Serial. 1st part. No. 33152 A.

MISCELLANY.

Crusher.

A New Form of Roll Crusher for Rock and Ore Crushing. Illustrations showing the design and construction of an improved type, called the centrifugal roll crusher. Details of its efficiency. 900 w. Eng News—March 8, 1900. No. 32937.

Magnesite.

The Magnesite Industry. Solon J. Vlasto. Concerning the production and uses. Ill. 1200 w. Eng & Min Jour—March 10, 1900. No. 32922.

Minerals.

Simple Tables for the Determination of the Common or Economically Important Minerals. Alfred J. Moses. Gives a tabulation of the important minerals by a few easily made tests and external characters. 1600 w. Sch of Mines Qr—Jan., 1900. No. 33018 D.

Nova Scotia.

New Mineral Discoveries in Nova Scotia. Edwin Gilpin, Jr. Read before the Nova Scotian Inst. of Science. Extract concerning coal, iron ore, etc. 2200 w. Col. Guard—March 9, 1900. No. 33-037 A.

Oil.

The California Oil Industry. Ernest

Horsfall Rydall. An account of the oil wells at Los Angeles and other points, and the excitement attending this discovery. Ill. 1300 w. Min & Sci Pr—March 17, 1900. No. 33099.

Separator.

A Centrifugal Separator (Schlender-separator). L. Kleritj. Illustrating and describing an improved hydraulic centrifugal machine for separating various ores and earths according to density and size of particles. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 10, 1900. No. 33261 B.

Tin.

The Blue Tier (Tas.) Tin Dykes. H. Grant. Information concerning this important discovery and the working of the deposits. 900 w. Aust Min Stand—Feb. 15, 1900. No. 33182 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Detailed list and classified summary. 2500 w. R R Gaz—March 9, 1900. No. 32934.

Freight Speeds.

Freight Train Speeds on the Northern Pacific. Discussion by E. H. McHenry, chief engineer of the road named. Also editorial. 2000 w. R R Gaz—March 2, 1900. No. 32769.

Great Central.

The New Line in London. W. B. Paley. An account of the first half year's working of the Great Central Ry. which is rather discouraging. 900 w. R R Gaz—March 30, 1900. No. 33198.

Parcels.

The Handling and Conveyance of Small Consignments. Discusses the report of Mr. Jasper, general goods manager of the North-Eastern Railway of Great Britain, and the advisability of carrying small consignments by passenger train. 2000 w. Transport—Feb. 16, 1900. No. 32824 A.

Russia.

Ten Years' Railroad Progress in Russia. Information from a recent statement made by the Minister of Finance on the economic condition of the country. 1600 w. R R Gaz—March 30, 1900. No. 33304.

Statistics.

The Railways of Germany, England, and France in 1895-1897 (Die Eisenbahnen Deutschlands, Englands, und Frankreichs in den Jahren 1895-1897). A tabulated comparison of equipment and operation of the three countries, showing the increase in Germany over England and France. 1500 w. Glückauf—Feb. 24, 1900. No. 33265 B.

FINANCIAL.

Dividends.

New Railroad Dividends. Editorial discussion of recent declarations, and the roads announcing an increase. 1200 w. R R Gaz—March 2, 1900. No. 32772.

Expenses.

Railway Maintenance of Way Expenses. Gives a table showing the relation of the maintenance of way expenses to the mileage, train mileage and operating expenses on a number of railways, with comments. 700 w. Eng News—March 8, 1900. No. 32941.

MOTIVE POWER AND EQUIPMENT.

Compressed Air.

Applications of Compressed Air in Railroad Shop Practice. Edward C. Schmidt. Extract from an address before the St. Louis Ry. Club. Notes some of the applications and the saving effected. 1800 w. R R Gaz—March 30, 1900. No. 33302.

Eccentrics.

An Improvement in Locomotive Eccentrics. Illustrated description of an improved style of split eccentric used by the Brooks Locomotive Works. 450 w. Am Engr & R R Jour—March, 1900. No. 32760 C.

Equipment.

The Increased Cost of Railway Equipment. Tabulated information of prices in 1898 and 1900 for material entering into the construction and repair of locomotive and car equipment. 1000 w. Ry Age—March 9, 1900. No. 32995.

Hospital Train.

The Princess Christian Hospital Train for South Africa. H. J. Shepstone. Illustrated description of an efficient train built in quick time. 1200 w. Sci Am—March 24, 1900. No. 33091.

Locomotive Boilers.

Supporting Rear Ends of Locomotive Boilers. Discussion of methods used, considering the best plan is to support the boiler by the mud ring, or by the mud ring and by lateral plate braces. Ill. 700 w. Am Engr & R R Jour—March, 1900. No. 32761 C.

Locomotive Design.

Some Questions in Locomotive Design. William G. Raymond. A study of a diagram of locomotive horse-power curves, and the questions brought out. 2000 w. R R Gaz—March 30, 1900. No. 33199.

Locomotive Performance.

A Run on the North-Eastern Railway. Charles Rous-Marten. An account of a run with one of the new locomotives recently built for this road, showing a highly creditable performance. 1500 w. Engr, Lond—Feb. 23, 1900. No. 32875 A.

Locomotives.

A Mogul Engine for the New York Central. Engraving and specifications. 300 w. R R Gaz—March 30, 1900. No. 33197.

Baldwin Engines for Paris Exhibition. Described and illustrated by half tones. 400 w. Loc Engng—March, 1900. No. 32752 C.

Express Passenger Engine, North-Eastern Railway. Engraving, sectional drawings and dimensions of an engine for work of heaviest and fastest description. 700 w. Engr, Lond—March 9, 1900. No. 33031 A.

Four-Coupled Crampton Engines. W. B. Paley. Illustrated account of engines built in 1861 and 2. They were designed for the London, Chatham & Dover R. R. 700 w. R R Gaz—March 9, 1900. No 32933.

Mr. Ivatts' Newest Great Northern Engines. Charles Rous-Marten. An account of runs made with recently built engines and descriptions of the types. Ill. 2600 w. Engr, Lond—March 16, 1900. No. 33151 A.

Narrow-Gauge Tank Locomotives. Illustrated description of a locomotive for the Londonderry and Lough Swilly Ry. of Ireland. 800 w. Engng—Feb. 23, 1900. No. 32870 A.

New Consolidation Locomotives for the Lake Shore and Michigan Southern. Descriptive specifications, important features and engraving. 800 w. R R Gaz—March 2, 1900. No. 32771.

New Express Locomotives (Nouvelles Machines d'Express). M. Desdouits. An illustrated description of the new simple expansion engines with piston valves, constructed for the French State Railways. Serial. Part I. 5000 w. 5 plates. Rev Gen de Chemins de Fer—March, 1900. No. 33267 G.

New Locomotives of the Chicago, Burlington and Quincy. Description and drawings of new freight locomotives and switchers. 1800 w. R R Gaz—March 30, 1900. No. 33301.

Recent Cooke Locomotives. Illustrated description of two recently completed engines having points of interest. 1600 w. Ry & Engng Rev—March 24, 1900. No. 33164.

Ten-Wheel Passenger Locomotive; Northeastern Ry. (England). Illustrated description of a large and heavy engine for hauling fast and heavy passenger trains. 1300 w. Eng News—March 29, 1900. No. 33191.

Lubrication.

Lubrication of Car Journals. Explains some of the causes of hot journals, illustrating the wear, with suggestions for the operation and care of cars. 1800 w. R R Gaz—March 23, 1900. No. 33109.

Models.

Early Models of Railways and Locomotives. An account of models exhibited as far back as 1808. 3700 w. Engr, Lond—Feb. 23, 1900. No. 32878 A.

Passenger Cars.

Passenger Cars for the Buffalo, Rochester and Pittsburg Railroad. Illlustrations and descriptions of interesting features of these cars. 1700 w. R R Car Jour—March, 1900. No. 32996.

Train Heating.

New Methods of Heating Railway Trains (Méthodes Nouvelles de Chauffage des Trains). A description of the methods employed on the various railways of France; both hot-water and steam are used. 3500 w. Revue Technique—Feb. 25, 1900. No. 33216 D.

Train Lighting.

Electric Lighting of Railway Carriages. Illustrates and describes a system recently tried on the Paris, Lyons, and Mediterranean. 1400 w. Engr, Lond—March 2, 1900. No. 32980 A.

Electric Train Lighting. Alton D. Adams. Briefly describes the methods tried with success. 1500 w. Sci Am—March 3, 1900. No. 32754.

Trucks.

Symons Boltless Cast Steel Truck. Illustrated description of a truck made of three members and no bolts. 500 w. Loc Engng—March, 1900. No. 32753 C.

Valve Gear.

The Hardie New Valve Gear. Illustrated description with tabulated results of distribution obtained. 400 w. R R Gaz—March 9, 1900. No. 32935.

Wheels.

Slid-flat Car Wheels. F. B. Farmer. Abstract of paper presented at Jan. meeting of the Northwest Railway Club. Discussing the causes. 1800 w. R R Gaz—March 9, 1900. No. 32932.

The Wear of Wheels on Sharp Cornered Rails. Editorial giving the history and development of the Am. Soc. C. E. rail section, with letter of inquiry, and letters showing the practice of dif-

ferent roads. 4800 w. Eng News—March 29, 1900. No. 33193.

NEW PROJECTS.

Africa.

The Cape-to-Cairo Project. J. Hartley Knight. A fully illustrated article treating of the growth of Mr. Rhodes' imperial conception, together with an account of the progress of the work. 4000 w. Engineering Magazine—April, 1900. No. 33293 B.

Asia Minor.

Railroad Construction in Asia Minor. Map and brief account of important extension uniting the Persian Gulf with Europe. 350 w. U. S. Cons Repts, No. 665—Feb. 28, 1900. No. 32745 D.

The Railway Struggle in Asia Minor. Editorial discussion of new railway projects under the control of Germany and of Russia. 1300 w. Engr, Lond—March 16, 1900. No. 33150 A.

Azores.

Proposed Railway in the Azores. Summary of a contract for the building and equipping of a modern narrow-gauge railway to connect Ribeira Grande, and Furnas, a local resort noted for its hot springs. 1200 w. U. S. Cons Repts, No. 681—March 19, 1900. No. 33053 D.

India.

New Projects of Railway Communication with India. J. M. Maclean. Discusses the great changes brought about by the construction of new roads in Russia, Siberia, and other countries, and the inaction of England. Also general discussion. 10000 w. Jour Soc of Arts—Feb. 16, 1900. No. 32774 A.

Switzerland.

Recent Railway Projects in Switzerland (Neue Schweizerische Eisenbahnprojekte). R. Moser. A review of a number of proposed railway schemes, including, among others, the railway and tunnel over the Splügen Pass. Three articles. 7500 w. Schweizerische Bauzeitung—Feb. 24, March 3, 10, 1900. No. 33246 each B.

PERMANENT WAY AND FIXTURES.

Address.

Maintenance of Way Problems. J. F. Wallace. Presidential address before the American Assn. A review of progress. 1800 w. Ry Age—March 16, 1900. No. 33083.

Ballasting.

Ballasting. Committee report presented to annual convention of American Ry. Engng. and Maintenance of Way Assn. 10000 w. Ry Age—March 16, 1900. No. 33085.

Chicago Shops.

Chicago and Northwestern Shops at Chicago. An illustrated description of extensive improvements being carried out. 1000 w. Am Engr & R R Jour—March, 1899. Serial. 1st part. No. 32762 C.

Maps.

Right of Way Maps. Concerning a fine set just completed by the engineering department of the Chicago & West Michigan and the Detroit, Grand Rapids and Western Rys. 5000 w. Ry Age—March 16, 1900. No. 33087.

Mountain Railway.

Where Grades and Curves Prevail. Description and views of an extension recently made to the Alamogordo and Sacramento Railway. 600 w. Ry Age—March 16, 1900. No. 33084.

Rail Creeping.

The Creeping of Rails on the Eads Bridge, St. Louis. Letter from N. W. Eayrs, the superintendent of the structure, concerning the amount of rail creeping and means adopted to accommodate it. 700 w. Sci Am—March 24, 1900. No. 33092.

Rails.

"Brittle" Rails and Phosphorus Content. Editorial discussion of complaints and of the cause of the trouble. 2000 w. R R Gaz—March 30, 1900. No. 33303.

Railway Bridges.

See Civil Engineering, Bridges.

Shops.

The Oelwein Shops. An illustrated description of the new plant of the Chicago Great Western Ry., with editorial comment on interesting features. 5500 w. Ry Age—March 2, 1900. No. 32847.

Signals.

Pipe-Connected Signals for Mechanical Interlocking. G. S. Pfasterer. Read before the Ry. Sig. Club. Favoring the pipe-connected signal, and reporting the satisfactory use on the Chicago & Eastern Illinois R. R. 1200 w. Ry & Engng Rev—March 10, 1900. No. 32997.

Virgillito's Automatic Electric Block-Signal System (Virgillito's Elektrisch Selbstthätige Eisenbahn-Blocksignale). L. Kohlfürst. The equilibrium of two opposing currents is disturbed by the entrance of a train on the block. 2500 w. Elektrotech Zeitschr—March 8, 1900. No. 33280 B.

Stations.

New Union Passenger Station at Springfield, Ill.: Illinois Central R. R. Description with two-page plate. 1700 w. Eng News—March 1, 1900. No. 32768.

Recent Passenger Stations (Ueber Neuere Personenbahnhöfe). H. Hoogen. With plans of the new stations at Altona, Kiel, Danzig, Coblenz, and other German cities, and a general discussion of station arrangements and facilities. 5000 w. Glaser's Annalen—Feb. 15, 1900. No. 33251 D.

The New Texas and Pacific Station at Fort Worth. Brief illustrated description. 300 w. Ry Age—March 16, 1900. No. 33086.

The Recent Improvements of the Stations of the Kaiser Ferdinand Northern Railway (Ueber Neuere Erweiterungsbauten auf Stationen der Kaiser Ferdinands-Nordbahn). Ernst Reitler. With numerous illustrations of new stations, together with plans and interior views of the locomotive works at Ostrau in Moravia. 4000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 16, 1900. No. 33235 B.

The South Terminal Station, Boston, Mass. Discussion of paper by George B. Francis. 2500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32841 E.

Switching.

Electro-Pneumatic Switching and Signaling System at the South Boston Terminal Station. Illustrated description. 1200 w. Sci Am—March 3, 1900. No. 32755.

TRAFFIC.

Freight.

French and German Practice in Grouping Small Shipments of Freight. Abstract of a paper to be presented at the International Ry. Congress at Paris. by Mr. Mange. 1200 w. R R Gaz—March 16, 1900. No. 33078.

Freight Rates.

Relative Freight Rates on Large and on Small Shipments. Editorial discussion of the principles that should govern in the making of rates. 2700 w. Eng News—March 1, 1900. No. 32766.

STREET AND ELECTRIC TRAMWAYS

Berlin.

The Applicability of Electric Driving to City Railways (Obauf Stadtbahnen der Elektrische Betrieb Eingefuhrt Werden Murs). H. Pforr. Discussing especially the case of the Berlin elevated railway, with diagrams showing the relation of speeds, stops, and efficiency. 4000 w. Glaser's Annalen—March 1, 1900. No. 33257 D.

Boston Elevated.

The Elevated Structure of the Boston Elevated Railway. Illustrated description of the foundations and metal work of a double-track road, showing all the details, and explaining the method of erection. 3800 w. Eng Rec—March 17, 1900. No. 33045.

The System of the Boston Elevated Railway Co. C. B. Fairchild. Illustrates and describes the line, the subway, the organization, the mechanical and electrical features and methods. 3800 w. St Ry Rev—March 15, 1900. No. 33002 C.

Brooklyn Heights.

Electrical Engineering on the Brooklyn Heights Railroad. Information concerning the building of the power houses and the keeping up the line voltage. Ill. 1000 w. R R Gaz—March 16, 1900. No. 33077.

Cable System.

The Cable Tramway System of Edinburgh. A comprehensive illustrated description of an installation having many improvements and interesting features. 10000 w. Tram & Ry Wld—March 8, 1900. No. 33114 A.

Compressed Air.

Traction With Compressed Air (La Traction à Air Comprimé). M. A. Monmerqué. A general account of the Mekarski system as employed in Paris since 1876. 5000 w. Rev Gen de Chemins de Fer—March, 1900. No. 33268 G.

Earning Power.

How to Determine the True Net Earning Power of Street Railway Properties. Edward E. Higgins. Describes the physical and financial features of an assumed property, as an illustration of principles, showing how the true earning power may be determined. 4700 w. St Ry Jour—March 3, 1900. No. 32900 D.

Electric Railway.

The Akron, Bedford and Cleveland Electric Railway. Illustrated description of the road and its equipment. 2000 w. Elec Rev, N. Y.—Feb. 28, 1900. No. 32758.

Electric Traction.

Notes on Electric Traction Under Steam Railway Conditions. Edward C. Boynton. An interesting paper discussing the question of local passenger service, the increase in traffic, and reduction of operating expenses. 8500 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 32912 D.

Electrolysis.

The Effect of Joint Resistance on Rail-

way Electrolysis. A. A. Knudson. Facts from experience showing that the independent return is not always a cure for electrolysis, and considering the only reliable remedy to be double overhead or underground construction. 1400 w. Am Elect'n—March, 1900. No. 32858.

Geneva.

Electric Street Railway in Geneva. Information concerning a railway projected by a citizen of San Francisco, and constructed by an American electrical engineer. 700 w. U. S. Cons Repts, No. 688—March 27, 1900. No. 33165 D.

Hill-Side Tramway.

A Hill-Side Electric Tramway Near Rouen. An illustrated description of an interesting extension to the tramway system of Rouen. 1300 w. Tram & Ry Wld—March 8, 1900. No. 33115 A.

Indicators.

Electrical Indicators in the Boston Subway. Illustrates and describes an apparatus adopted to prevent accidents and facilitate the handling of crowds. 600 w. R R Gaz—March 23, 1900. No. 33111.

Interurban.

The Rapid Railway—Detroit to Port Huron. Particulars concerning important extensions, and the facilities offered by this new road. 1500 w. R R Gaz—March 23, 1900. No. 33112.

Long Distance.

High Speed Three-Phase Railway from Toledo to Norwalk, Ohio. An illustrated account of this new 60 mile railway, soon to be opened. 4000 w. St Ry Jour—March 3, 1900. No. 32898 D.

Metropolitan Station.

Main Power Station and Transmission System of the Metropolitan Street Railway Company of New York. Illustrated detailed description of the main power station and its equipment and the distributing system. 8500 w. St Ry Jour—March 3, 1900. No. 32897 D.

Mountain Road.

The Jungfrau Three-Phase Electric Railway. Ernest Kilburn Scott. A very fully illustrated description of the latest development in mountain railroading in Switzerland. 4500 w. Engineering Magazine—April, 1900. No. 33296 B.

New Road.

The Milford, Attleboro and Woonsocket Street Railway. William D. Ennis. Describes this new road and its equipment and operation. Ill. 2500 w. Elec Wld & Engr—March 17, 1900. No. 33069.

Overhead.

The Construction of Overhead Equipments. A brief illustrated account of the work of construction of an overhead line for tramway work, with a view to pointing out some of the difficulties that may be encountered. 1900 w. Elec Rev, Lond—Feb. 23, 1900. Serial. 1st part. No. 32881 A.

Power Station.

The Kingsbridge Power Station of the Third Avenue Ry., New York City. Burcham Harding. Illustrated description of interesting features. 4000 w. Eng News—March 22, 1900. No. 33118.

Stray Currents.

The Action of Electric Tramway Currents on Submarine Telegraph Cables and Other Electric Circuits. Andrew Jamieson. Read before the Inst. of Engs. and Shipbuilders of Scotland. Deals with one of the causes of delay in the transmission of telegrams between England and Cape Town. Also editorial. Ill. 5400 w. Elect'n, Lond—March 2, 1900. No. 32883 A.

The Influence of Stray Currents from Electric Tramways Upon Magnetic Observatories (Untersuchungen des Einflusses der Vagabundirenden Ströme Elektrischer Strassenbahnen auf Erdmagnetische Messungen). J. Edler. A very full account of the investigations at the Potsdam observatory, with reproductions of the photographic records. 5000 w. Elektrotech Zeitschr—March 8, 1900. No. 33279 B.

Suburban.

A New England Suburban Railway. An illustrated description of the Exeter, Hampton and Amesbury street railway. 1600 w. St Ry Jour—March 3, 1900. No. 32899 D.

Suspended Road.

The Suspended Railway Between Barmen, Elberfeld, and Vohwinkel (Le Chemin de Fer Suspendu de Barmen-Elberfeld-Vohwinkel). Alfred Boudon. A very fully illustrated account of this overhead electric railway. The carriages are suspended from a single overhead rail, and the road follows in great part the river Wupper. 3000 w. Génie Civil—March 10, 1900. No. 33210 D.

Three-Phase.

Three-Phase Installation of the Newtown (Pa.) Electric Street Railway. Brief illustrated description. 700 w. St Ry Rev—March 15, 1900. No. 33003 C.

Vienna.

The Track of the Vienna City Railway (Der Oberbau der Wiener Stadtbahn). Hugo Koestler. Giving details of the rails and joints and general track construction of the road. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—March 9, 1900. No. 33239 B.

Book Reviews

The Filtration of Public Water Supplies. By Allen Hazen, Assoc M. Am. Soc. C. E., etc. Third edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Limited. Cloth; 8vo.; pp. 321. Illustrated.

Mr. Allen Hazen is so widely known in the United States and Europe as an authority on the filtration of public water supplies, that a new edition of his book upon that subject is certain to be well received. Since the appearance of the first edition in 1895, scientific investigations have extended our knowledge of the purification of turbid waters, and Mr. Hazen has taken advantage of this recently acquired information to give his readers a discussion of the principal topics relating to the removal of excessive amounts of silt, clay, sand, etc. A chapter on the removal of iron from ground water has been supplied, as have several statistical tables and a description of the Albany, N. Y., filtration plant. The older portion of the book, dealing with the construction and operation of slow sand filters, has been retained and the original chapter on the relation between impure drinking water and disease has been rewritten. In the enlargement the scope and importance of the book have been greatly increased. To those persons who doubt the importance of pure water supplies or question the practicability of removing bacteria and other impurities by filtration, Mr. Hazen has given a strong answer. Of the half dozen works dealing with the subject, none is clearer in style or more essential in information. The book is handsomely illustrated and printed, and contains several appendices, and a valuable bibliography for the convenience of those who desire to study the subject further.

Copper Manual. Copper Mines, Copper Statistics, Copper Shares, and a Summary of Information on Copper, etc. New York: D. Houston & Co., Metal Brokers. Volume 2, 1899.

The contents of the book are accurately described by the sub-title. While essentially devoted to statistical information concerning American copper mines and mining companies, on both the operative and the fiscal sides of their management, it contains also many general tables of production and prices in the United States and in Europe. It is handsomely printed, and is a useful book within the scope designed by its publishers.

Handbook of Testing Materials for the Constructor. Part 1. Methods, Machines, and Auxiliary Apparatus. Two volumes: Vol. I., Text; Vol. II., Illustrations. By Professor Adolf Martens, Director of the Royal Testing Laboratories at Berlin and Charlottenburg. Authorized Translation and Additions, by Gus. C. Henning, M. E. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1899.

It is altogether unnecessary to speak of the importance and value of the monumental work which has been done by Professor Martens at the Charlottenburg Testing Laboratory, and this first portion of his treatise upon the general subject has been awaited with especial interest by constructors in the English-speaking countries.

There is probably no one subject in the domain of engineering in which such a thoroughly organised effort is being made at unification and systematisation as in the matter of methods of testing materials of construction, and both the author and the translator of these volumes have been active in the work, so that the book may fairly be considered as the latest expression of the results of that association.

Some general idea of the contents may be obtained when it is understood that they include an introductory essay upon the technological properties of materials in general, an exhaustive section on the whole subject of the resistance of materials, an examination of standard of quality for technological value of materials of construction, and a most complete and fully illustrated descriptive section, including practically all the machines which have yet been devised for the purposes of testing.

The thoroughness with which the work both of author and translator has been done can only be appreciated by an examination of the books themselves, and a further assurance of the value of the translation is had in the knowledge of the close association and friendship existing between the able director of the Charlottenburg laboratories and his friend and colleague in the Council of the International Association for Testing Materials.

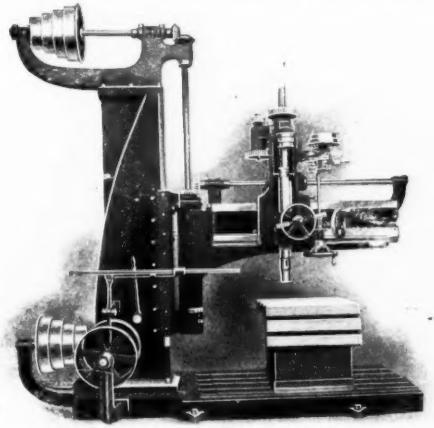
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Baird Radial Drilling Machine.

THIS machine is gear driven from the horizontal top shaft. The back gearing is directly on the head, relieving shafts and gears from strain. The radial arm swings easily on ball bearings, and is raised and lowered by power. The head is moved along the arm by a hand wheel, rack and spiral pinion, and cannot vary its position by accident or jar. The spindle is back geared, counterbalanced, has a quick return



motion and four changes of feed, by hand and power. The speeds and feeds are in accurate geometrical progression. It has a broad and heavily ribbed base plate. Hand wheels and operating levers are within easy grasp of the operator. It is driven by two friction pulleys, placed at the side or back of column, as may be ordered, allowing the machine to be placed at right angles to, or in line with, the main shaft.

Manufactured by the U. Baird Machinery Co., 723-725 Water street, Pittsburg, Pa.

Maurer Terra Cotta Construction.

THE successful ordeal through which many of our large buildings (having any pretensions at all to being fireproof) have gone during the past year has not only justified their construction, but awakened the public to a realizing sense of the virtue of fire proofing.

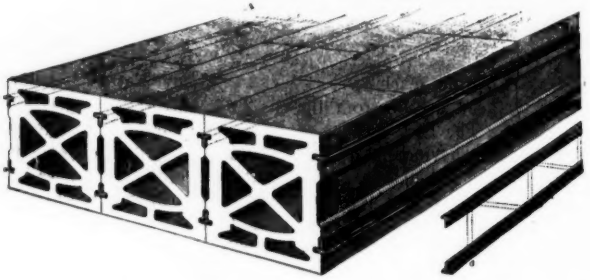
The high price of iron, ruling for some time and likely so to continue, coupled with the quantity of such material rendered essential by the prevailing methods of fireproof construction, has restricted its use solely to large office buildings, and the erection of moderately expensive dwellings was confined to brick (outside) and wood.

So far as fireproof qualities enter into consideration, both of these may be placed in the same category, both have wooden beams, joists, floors, etc.

With the advent, however, of the Maurer terra-cotta system of fireproofing, doing away with iron beams, girders, bolts, etc., it becomes practicable to build even the

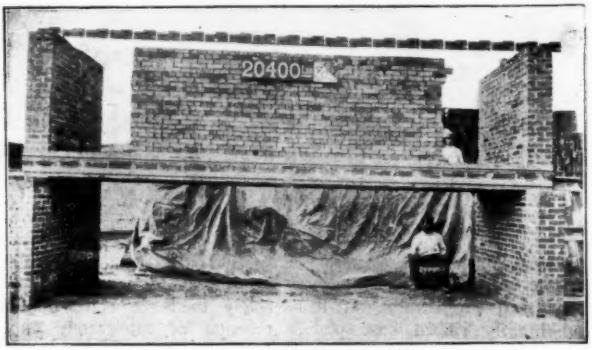
most modest of dwellings thoroughly fireproof.

Tests of the system made by the manufacturers show that it is possible to throw an arch 20 feet in the span clear from wall to wall without the use of iron beams and



girders, or any other support other than that embodied in the system, and yet such arch is capable of sustaining weight of 510 pounds or more to the square foot.

All the terra cotta blocks of this construction are made square and of varying lengths and depths to accommodate the spans, there being no keys or skews. All lateral strain on walls is removed and the two iron T rods, presenting virtually a



rivetted girder, repeated between each course, provide amply for the vertical strain.

The first cut shows the design of the terra cotta hollow blocks and the two iron T rods, as well as the method of construction. It will be observed that the T rods fit closely into grooves on the sides of the blocks and are thoroughly embedded in cement, thus being efficiently protected from fire by a covering of terra-cotta. The blocks are laid in bond. The other cut shows the test of an arch twenty feet span in the clear and loaded with 20,400 pounds on forty square feet of the arch; the load well clear of the adjoining walls to avoid "bonding" materially increases the severity of the test. This load being left on for several months, showed a deflection of but 9-16 of an inch in the middle of the arch, which sprung back to its original position on removal of the load, proving its elasticity.

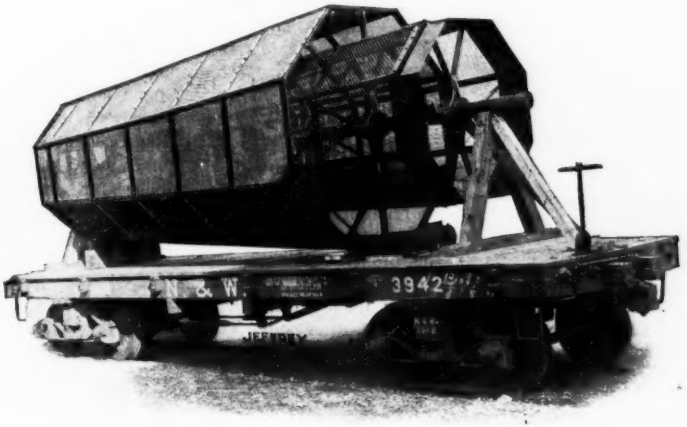
This demonstrates that by this method an arch of twenty feet span in the clear can be laid without the use of iron beams, girders, etc., and consequently at an appreciable saving in cost of construction. The manufacturers have erected at their works, for occupancy of their employees, three houses, each 22 x 42 feet, two stories high, with sub-cellar, each containing eight rooms, provided with all modern improvements, steam-heated, hot and cold

water, etc., the roof covered with red terra-cotta ornamental roofing tiles, providing against fire from outside causes, besides improving their appearance. The partitions are of 2 inch terra cotta. The cost of these thoroughly fireproof buildings proved but moderately in excess of wooden construction.

Henry Maurer & Son, 420 East Twenty-third street, New York, are the manufacturers, and issue a comprehensive pamphlet, giving constructive details, etc., of this new method and will send it on request.

Jeffrey Chip Screen.

THE revolving screen illustrated herewith is one of the many different styles



made by the Jeffrey Manufacturing Company, of Columbus, Ohio. This screen was specially designed for the screening of chips in the pulp mill of the West Virginia Pulp & Paper Company, at Covington, Ky. It is 25 feet in length and 9 feet in diameter at its largest end; it is mounted substantially upon a 7-inch shaft, which is 30 feet in length, while it is covered with steel cloth to suit the requirements at this mill. A special catalogue on screening machinery can be had by addressing the Jeffrey Manufacturing Co., Columbus, Ohio, or at its branches.

An Improved Drill-Grinder.

THE improvement in this machine consists in the fact that only one preliminary adjustment is required, whereas in other drill grinding machines a number of them are necessary before a drill can possibly be ground. The mechanism by which these results are obtained may be described briefly as follows:

The holder of this machine swings upon a journal positioned back of the grinding face of the wheel, the axial line of which—if extended upwardly—would pass through the body of the wheel and intersect the apex of the "V" holder substantially at the grinding surface of the wheel; consequently a small drill resting in the bottom of the holder would have its point near this imaginary line, and the cone upon which the cutting end of the drill would be ground would be very small, as the circle that it swings on at that point is circumscribed.

The angles of the "V" sides of the holder are formed in such relation to this axial line of oscillation that as drills increase in size, they must rest further above the apex of the holder. When in position to grind their points will be thrown further ahead of this imaginary line just in proportion to their increase in size. Therefore, the lines upon which the machine itself is constructed become their own adjust-

ing device, and automatically accomplish in this machine the results obtainable in others only by the manipulation of caliper devices, gage jaws, chucks, etc. It will be seen that there is no guess-work about the solution of this problem. The lines upon which it is solved are both mechanically and scientifically correct. It will also be readily seen that by the proper arrange-

ment of these angles and lines in relation to each other, drills of different sizes automatically find their places in the proper position to be ground mechanically correct. A small drill cannot possibly occupy the place of a large one, and *vice versa.*

The machine is made by the Fuller Mfg. Co., successors to the G. T. Eames Co., Kalamazoo, Mich.

The Bard Adjustable Bushing.

THE accompanying illustration shows the Bard adjustable bushing, a new appliance for use with die-stocks of all sizes. The bushing is fitted with three hardened jaws, which are moved to and from the center by means of a cam plate, and by fastening the plate with the thumb-screw the jaws are firmly held in any desired position. The bushing is made to fit any die-stock, in place of the common ring bushing, and adjusts to all sizes of pipes or bolts. The adjustable jaws always make a perfect center for the pipe and, fitting closely around the pipe, insure cutting a straight thread. When once attached to the die-stock it may always remain there, being adjustable to any size of pipe or bolts that the stock will thread. It thus does away with the necessity of carrying a number of loose ring bushings with each stock, and saves all the time lost in hunting for and changing the bushing for each different size of pipe or bolt.

In threading short nipples with this bushing it is never necessary to file down the coupling of the nipple holder, as it is with the ordinary bushing. All this trouble and delay is overcome by the adjustable bushing which is fitted to every size.

The adjustable bushing always guides the pipe perfectly to the center and insures a straight head; it may always be left in the stock, and is adjustable to any size pipe or bolts that the stock will thread. This bushing always fits the pipe closely.

The Bard bushing is manufactured by the Armstrong Manufacturing Co., of Bridgeport, Conn., who will send full details and prices upon application.

The Sterling Gasoline Engine.

THE illustration shows a portable gasoline engine suitable for operating well drills, saws, pumps, stone crushers, etc.

The driving pulley is a friction-clutch pulley, simple in construction, and with means for taking up the wear of the clutch shoes, which are lined with hard wood. The machine that is being driven can be stopped and started at will, while the engine continues to run. There is

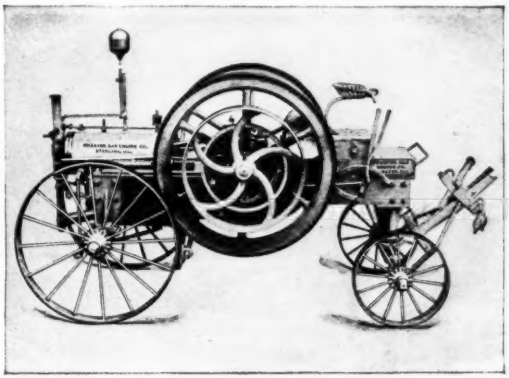
room for an ordinary pulley on the opposite end of crank shaft, of any size desired, so that two machines can be run at one time. Or if the diameter of the friction-clutch pulley be not right, any size of pulley needed for special work can be fitted.

Mufflers for the exhaust, peculiar to the "Sterling," are furnished, which reduce the noise, so there is not as much as is made by the steam engine exhaust. The gasoline tank has capacity for over a day's run and is shown back of the seat.

The manufacturers, the Charter Gas Engine Co., 324 Second street, Sterling, Ill., will furnish further details on request.

Industrial Notes.

The Berlin Iron Bridge Co., of East Berlin, Conn., have made an extensive purchase of real estate at Pittsburg, Pa., and have already started on a new plant, to be located at that point. They have bought



fifty acres of land between the Pennsylvania Railroad and the Ohio River, upon which they will locate their plant, and in addition, fifty acres back from the river. Upon this latter piece they will put up a number of houses for the use of their employees. The foundations for the buildings are now being put in place, and it is the intention that this plant will be in complete operation by the first of July, as the orders for the machinery equipment have been placed for some months. The office building will be 60 feet square and four stories in height, and will be a fireproof construction throughout. The template shop will be 60 feet in width and 300 feet in length, two stories high. The main shop will be constructed entirely of steel and glass, and will be 220 feet wide and 700 feet long. The entire plant will be equipped with new machinery, which will be of the heaviest and most modern design, and the orders have been placed with the Hilles & Jones Co., Wilmington, Del.; the Cleveland Punch & Shear Works Co., Cleveland, Ohio; the Niles Tool Works Co., Hamilton, Ohio, and the Brown Hoisting & Conveying Machine Co., Cleveland, Ohio. The hydraulic plant will be very elaborate, and will be furnished by Wm. H. Wood, Media, Pa. The floor surface of the main shop is to be controlled by twenty-three traveling cranes, of various sizes and design, of the heaviest capacity, all furnished by the Chisholm & Moore Manufacturing Co., Cleveland, Ohio. The fuel used will be natural gas, the engines being furnished by the National Meter Co., New York, N. Y. The machinery will be operated throughout by electricity, the generators and motors being furnished by the General Electric and Westinghouse companies. The Berlin Iron Bridge Co. have had a very wide experience, extending over long years, in designing and building manufacturing plants, and they intend that their own plant shall be the most complete of its kind in the world. No pains or expense have been spared in making it such, and the company are now taking contracts to be built at this plant for delivery after July 1. The capacity will be from 3,000 to 4,000 tons per month.

James McCrea & Co., manufacturers of the Climax steam joint clamp, 11 and 13 South Canal street, Chicago, inform us that a large percentage of their orders at this time come from people who have used the Climax steam joint clamps from

the time they commenced manufacturing them. This shows that the device is no experiment, and certainly the cost is much less than shutting down the plant and pulling down the pipes in order to stop leaks in fittings.

After May 1, the New York office of the New York Safety Steam Power Co. will be moved from 107 Liberty street to 113 Liberty street. This company is building a pair of 14 x 16 horizontal engines, which are to be used by the National Storage Co., Jersey City; two 13 x 12 horizontal automatic engines, to be direct connected to Westinghouse dynamos; a 12 x 12 horizontal automatic engine, direct connected to a General Electric dynamo, which is to be shipped to the Hawaiian Islands for use on a plantation; a 15½ x 16, and a 14 x 14 horizontal automatic engine, direct connected, to be used by the Record Publishing Co., of Philadelphia. They also have in hand the building of several Worthington water-tube boilers, one of 200 h.p., being the second ordered by the Manhattan Hygiea Ice Co.; a 144 h.p. for the Jackson Iron Works, Aldene, N. J.

The New York office of the Edward P. Allis Co., Milwaukee, is now located at 95-97 Liberty street.

The Ferracute Machine Co., Bridgeton, N. J., have three exhibits at the Paris Exposition. Their main exhibit is in Block 8, American Machinery Department, while they have an exhibit of coining machinery in the United States government exhibit, and one of heavy machinery in the machinery annex, Block 5, Vincennes.

The town of Union, S. C., has given contract for a filtering plant for the town supply, to the New York Filter Manufacturing Co., 26 Cortlandt street, New York; Morgantown, W. Va., has also placed contract to increase the New York filter plant already installed by that town.

The Navy Department has placed an order with the New York Air Compressor Company, New York, for two duplex compound air compressors of large capacity for the Charlestown Navy Yard, Boston, Mass.

The J. A. Fay & Egan Co., of Cincinnati, O., have been awarded, in the Champs de Mars, at the coming Paris Exposition, the largest space of any firm in the United States, and they expect to make a complete display of wood working machinery. At the Exposition of 1889 this company was awarded the Grand Prix, together with the Medal of the Legion of Honor. This year they expect to at least hold their own, and, perhaps, surpass their showing made in 1889, when they had 5,000 square feet.

We are informed that the demand for the paints, colors, varnishes, etc., of Harrison Bros. & Co., Inc., Philadelphia, is so great that their facilities for producing these goods are taxed to the utmost. This fact demonstrates the popularity of the products bearing the name of "Harrison."

The United States government has placed an order with the New York Filter Manufacturing Co., 26 Cortlandt street, New York, for a large filter-plant to furnish filtered water for the experimental model basin in the Navy Yard at Washington, D. C.

The Dorner Truck & Mfg. Co. have removed their factory from Cleveland, O., to Logansport, Ind., where they have three new modern shops—foundry, machine, and blacksmith—specially fitted for their work, and they are now in shape to fill orders promptly for trucks, car wheels, track cleaners, brake shoes, bearings, etc.

The town of Marinette, Wis., has contracted with the O. H. Jewell Filter Co., of Chicago, Ill., for a filter plant with a daily capacity of three million gallons.